

Figure 26. Selected issues of interest to both the GLNP and IURTP.

5.0 LAND ACQUISITION AND PROTECTION

5.1 Adjacent Land Use Zoning

5.1.1 Zoning Designation Evaluation

A review of zoning and land use surrounding the Griffy Lake Nature Preserve reveals a variety of current zoning districts and land uses from medium density residential to institutional and agricultural to conservation reserve. Monroe County has zoning jurisdiction over the majority of the land in the Griffy Lake watershed, and has done a good job of defining zoning districts in the area that err on the side of conservation and protection of the lake and nature preserve (Figure 27).

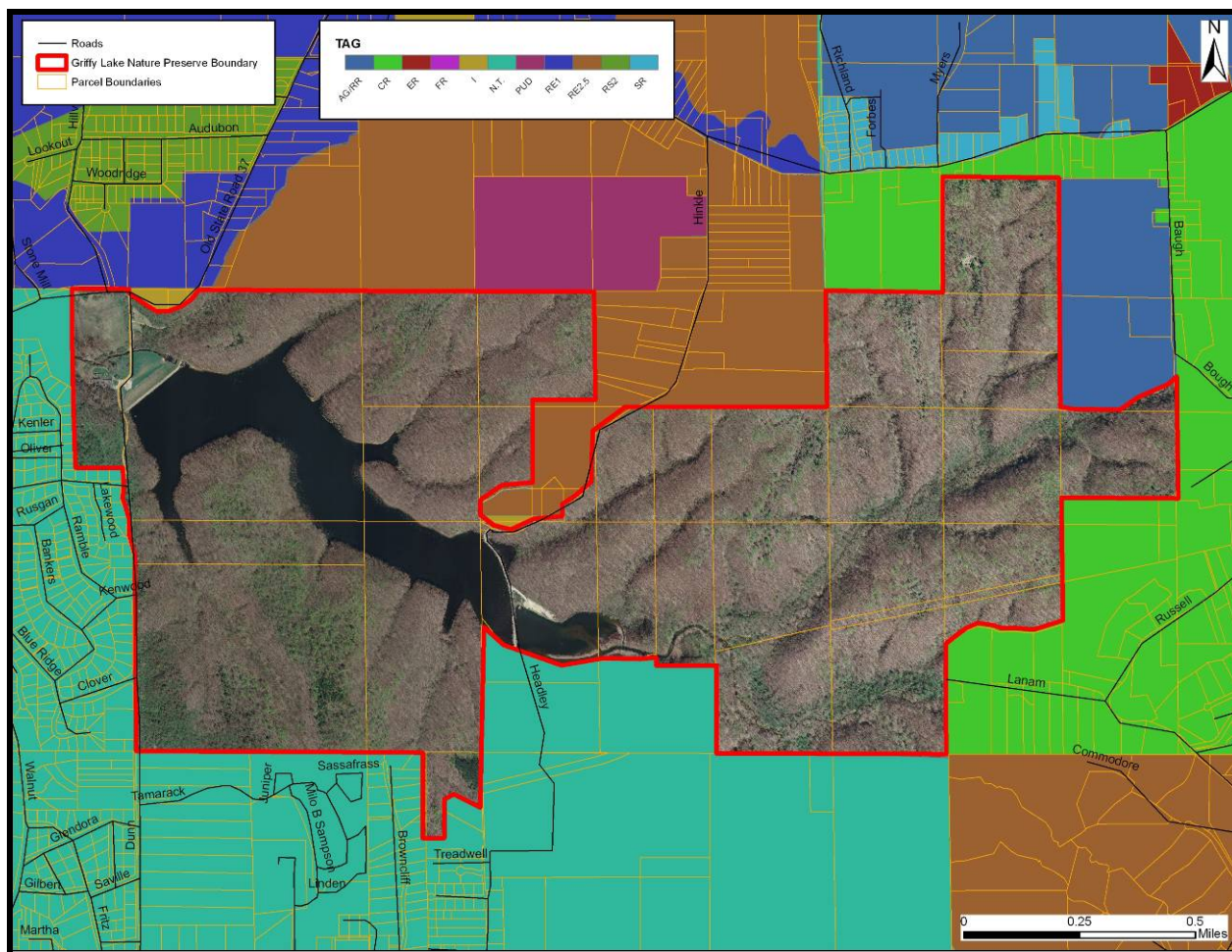


Figure 27. Zoning designations surrounding Griffy Lake Nature Preserve.

The City of Bloomington has zoning jurisdiction over land in the Griffy Lake watershed to the west and south of the Griffy Lake Nature Preserve. All of this land is in the institutional zoning district. This district is defined in the City of Bloomington Unified Development Ordinance (UDO), Chapter 20.02, Sections 490, 500, 510, and 520. All of this land is owned by Indiana University and, according to the UDO, has a large number of allowable uses. Many of these uses could be seen as a threat to the lake and nature preserve

Zoning Tags are defined by the Monroe County Zoning Ordinance Chapters 802 and 833 and are as follows:

Agriculture/Rural Reserve (AG/RR) District (mid-blue). The character of the AG/RR District is defined as that which is primarily intended for agriculture uses, including, but not limited to, row crop or livestock production, forages, pasture, forestry, and single-family residential uses associated with agriculture uses. Single-family uses are limited and include very low density, rural non-farm related single family uses and areas not in (major) subdivisions. The AG/RR District purposes are to encourage the continuation of agriculture and associated single family residential uses; to discourage the development of residential subdivisions and non-farm-related nonresidential uses; to protect the environmentally sensitive areas, such as floodplains and steep slopes; and to maintain the character of the surrounding neighborhood. Based on these purposes, the number of uses permitted in the AG/RR District is limited. However, some uses

are conditionally permitted. The conditions placed on these uses are to ensure their compatibility with the agriculture-related uses. The development of new non-farm residential activities proximate to known mineral resource deposits or extraction operations may be buffered by increased setback distance.

Conservation Residential (CR) District (lime green). The character of the CR District is defined as that which is primarily intended to provide a residential option (planned unit or cluster development) at environmentally sound locations while protecting the environmentally sensitive watersheds of Lake Griffy and Monroe Reservoir. The CR District's purposes are to protect the environmentally sensitive watershed, especially the floodplains and steep slopes; to permit limited single-family residential development on very large lots or in subdivisions (planned unit or cluster development) at environmentally sound locations; to discourage the development of nonresidential uses; to discourage the development of sanitary sewer systems, except for existing development; and to maintain the character of the surrounding neighborhood. Development in the CR District is hindered by concern over the watershed environment, and, in some cases, extreme topography, poor access, and the availability of few or no public services. Based on these limitations, the number of uses permitted in the CR District is limited; however, some uses are conditionally permitted. The conditions placed on these uses are to insure their compatibility with the watershed environment and low-density residential uses. The development of new residential activities proximate to known mineral resource deposits or extraction operations may be buffered by increased setback distance.

Forest Reserve (FR) District (purple). The character of the FR District is defined as that which is primarily intended for the preservation of forests, recreational areas, parks and greenways, limited agricultural uses and very low density single family residential uses. The FR District's purposes are to permit limited single family residential development on very large lots; to discourage the development of residential subdivisions and nonresidential uses; to protect environmentally sensitive areas, such as floodplains and steep slopes; and to maintain the character of the surrounding neighborhood. Development in the FR District is hindered by extreme topography, poor access, and the availability of few or no public services. Based on these limitations, the number of uses permitted in the FR District is limited; however, some uses are conditionally permitted. The conditions placed on these uses are to insure their compatibility with the low-density residential and public open space uses.

Estate Residential (ER) District (brick red). The character of the ER District is defined as that which is primarily intended for low density, single family residential development on relatively flat land in areas that have some, but not full, public services, generally along or near major county roads or state highways. The ER District's purposes are to permit limited single family residential development on large lots; to discourage the development of sanitary sewer systems except for existing development; to discourage the development of residential subdivisions and non-farm nonresidential uses; to protect environmentally sensitive areas, such as floodplains, karst, and steep slopes; and to maintain the character of the surrounding neighborhood. Based on these limitations, the number of uses permitted in the ER District is limited; however, some uses are conditionally permitted. The conditions placed on these uses are to ensure their compatibility with the low-density residential uses. The development of new residential activities proximate to known mineral resource deposits or extraction operations may be buffered by increased setback distance.

Estate Residential 2.5 (RE2.5) District (brown). The intent of this district is to require minimum lot sizes of 2.5 acres where sensitive environmental resources exist. Such environmental resources may include karst formations, wetlands, hillsides, heavily wooded land, and the lake's

watershed. The dual purposes of this district are to protect these sensitive environmental resources and to permit a rural level of development which will not endanger and can be used to protect these sensitive resources.

Estate Residential 1 (RE1) District (royal blue). The intent of this district is to accommodate large lot, estate type residential uses in a rural environment along with limited compatible agricultural uses. It is meant specifically to accommodate those persons who desire estate type living; to maintain a pattern of growth that is consistent with the cost-efficient provision of urban services to promote compactness in the city structure; to provide for development in a rural setting not necessarily requiring urban utilities; and to provide for limited compatible agricultural uses.

Institutional (I) and No Tag (NT) Districts (tan and turquoise, respectively). Note the abbreviation NT designates No Tag. This area represents zoning in the City of Bloomington Jurisdiction, and the city has designated this as an Institutional district (City of Bloomington UDO, 20.02.490). The Institutional District is intended to be used to provide regulations for properties owned by state, county, city, and quasi-public institutions. These include, but are not limited to, parks, schools, cemeteries, golf courses, and other facilities. Plan Commission and Board of Zoning Appeals Guidance indicate that these districts are designed to ensure that institutional uses are adequately distributed throughout the community to prevent segments from being under served. Additionally, institutional uses should be located in areas that contain adequate public services. In particular, educational uses must be accessible via all modes of transportation.

Planned Unit Development (PUD) District (maroon). The character of the Planned Unit Development (PUD) District is defined as an area where the placement of large scale, unified land developments, typically involving a configuration and/or mix of uses not otherwise permitted "as of right" under the Zoning Ordinance, may nevertheless promote the purposes of the Zoning Ordinance and may be considered by the County and the Commission. Additional clarification of the process for approval of Planned Unit Developments is detailed in Chapter 811 of this Ordinance.

Suburban Residential (SR) District (light blue). The character of the SR District is defined as that which is primarily intended for existing, possibly nonconforming, recorded single family residential subdivisions and lots of record. The SR District's purposes are to accommodate existing, substandard subdivision developments and lots; to permit the build-out of single family residential uses in those developments and lots; to encourage the development of sanitary sewer systems for the existing development in the Lake Lemon area; to discourage the development of nonresidential uses; to protect environmentally sensitive areas, such as floodplains, karst, and steep slopes; and to maintain the character of the surrounding neighborhood. Therefore, the number of uses permitted in the SR District is limited; however, some uses are conditionally permitted. The conditions placed on these uses are to insure their compatibility with the residential uses. The need for expanding this district beyond the areas designated on the Official Zone Maps on the date of the adoption of the zoning regulations is not anticipated or encouraged.

Single Dwelling Residential (RS2, RS3.5, RS4.5) Districts (olive green). These three districts are intended to serve the traditional single family dwelling needs of the City of Bloomington. The RS Districts are maintained in a single section of the ordinance for easy interpretation; the primary difference among these three districts is density. By providing three districts, zoning is established which is appropriate to the existing development in each district. These districts provide a flexible density structure whereby developments of varying densities are permitted

subject to appropriate review. The intent of these districts is specifically to provide for the development of single family neighborhoods; to assure the protection of existing residential environments; and to promote compatibility with the existing pattern of development.

5.1.2 Environmental Constraints Overlay (ECO) Zone

In addition to the zoning districts, the Monroe County also has an Environmental Constraints Overlay (ECO), which restricts building and development in specific areas around Griffy Lake and the Griffy Lake Nature Preserve (Table 2; Figure 28). The highest restrictions exist within areas immediately adjacent to Griffy Lake. These areas rate as Area 1 and require a minimum lot size of five acres with no more than 1 acre of development. Additionally, development cannot occur in areas with a 12% or greater slope. As one moves farther away from the lake, the restrictions lessen. However, development within the Griffy Lake watershed rates as Area 3 at a minimum. These restrictions require a minimum of a 2.5 acre lot size with no more than 1 acre of development. Additionally, development cannot occur in areas of 18% slope or greater.

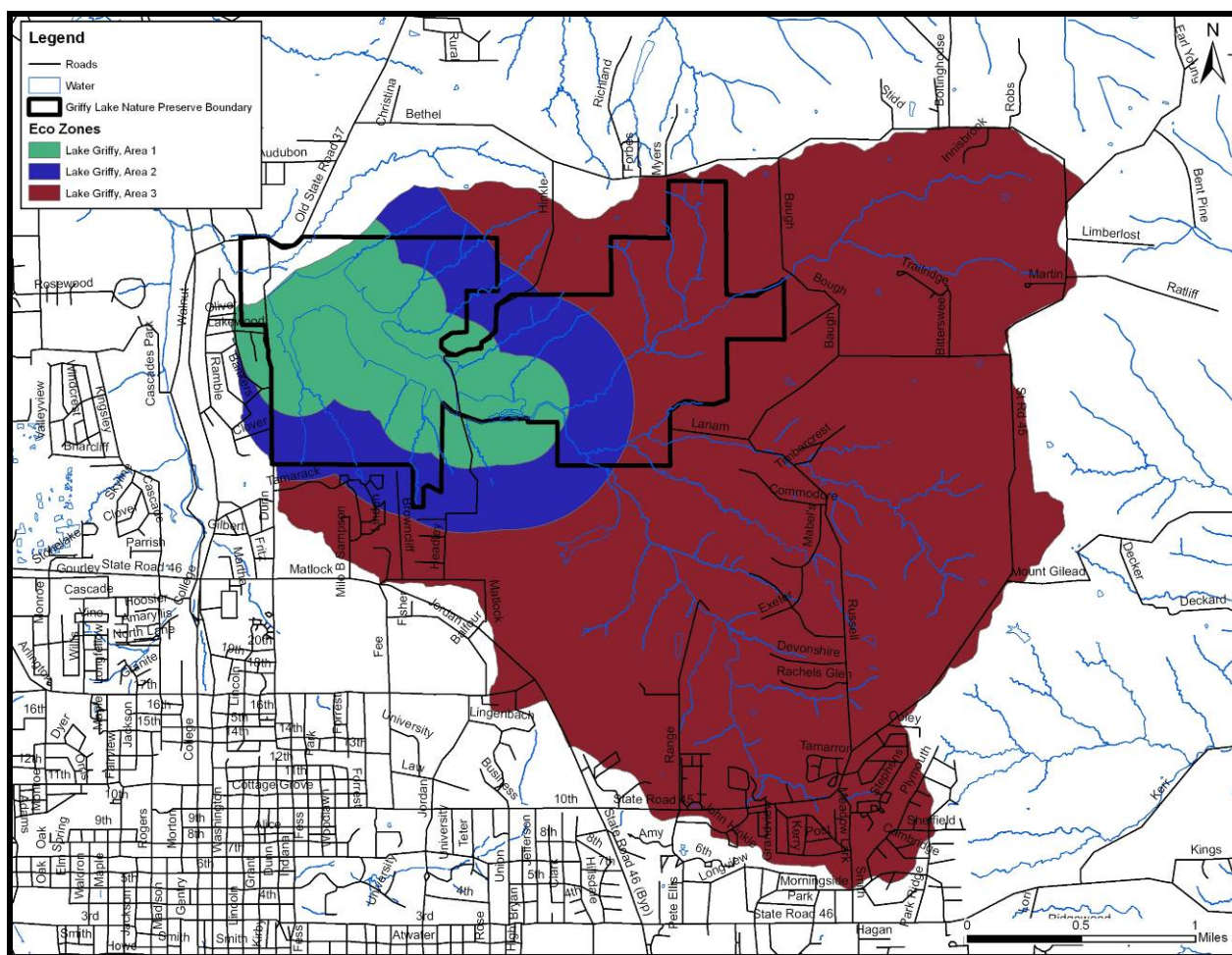


Figure 28. Environmental Constraints Overlay (ECO) within the Griffy Lake Nature Preserve and Griffy Lake watershed.

Table 2. Environmental Constraints Overlay (ECO) building limitations and requirements.

ECO Area	Slope limitation for land disturbance	Minimum lot size	Limit for contiguous buildable area
Area 1	12%	5 acres	1 acre
Area 2	15%	2.5 acres	1 acre
Area 3	18%	2.5 acres	1 acre

Note: the county planning department is completing an impervious surface and water quality study for the Griffy watershed, which will be completed in May. We should consider including it as part of this planning document or as an appendix. It fits very well into this section, and will provide a baseline for impervious surfaces in the watershed and a prediction of future impervious surfaces based on current zoning.

5.1.3 Zoning Recommendations

In general, it is important to monitor any changes in land use that might result in higher rates of chemical runoff or other contaminants entering and flowing through the GLNP and affecting the soils or water. Invasive plant species propagation is another concern from adjacent land uses.

The primary goal of the Bloomington Parks and Recreation Department in monitoring land uses and zoning around the Griffy Lake Nature Preserve and within the Griffy Lake watershed should be to ensure there are no changes that could be harmful to the GLNP. The department should work closely with the city and county planning departments so that they are informed any time there is an application for a land use variance or a transfer of ownership of an adjacent property. The Parks and Recreation Department then has an opportunity to influence planning department decisions.

At appropriate times and under certain political climates, Bloomington Parks and Recreation may want to consider being an advocate for more restrictive zoning in the Griffy Lake Watershed that is more conservation and preservation oriented. Additionally, as recommended by the Bloomington Environmental Commission (EC):

- The BPR should conduct a study regarding the adequacy of the ECO and should work with the City and County to increase and coordinate zoning protection for the Griffy Lake watershed. At a minimum, zoning restrictions and the ECO should be comparable to environmental protection ordinances of Bloomington's UDO including karst feature protection, stream buffer requirements, stormwater management, and tree preservation.
- Additionally, the BPR should be notified in advance of all pending development and variance requests within the watershed allowing for BPR to have adequate opportunity for input on said requests.

5.2 Sensitive Habitat Protection

Several areas at the site have been identified as Sensitive Habitat Areas for various reasons. Sensitive Habitat Areas include slopes of greater than 30%, Emergent Marsh, Floodplain Forest (Wet, Wet-Mesic, and Mesic), and Dry-Mesic Upland Forest. In addition, two locations dominated by large (greater than 24 inches diameter at breast height) trees were also noted. Areas identified as Sensitive Habitat Areas are mapped in Figure 29.

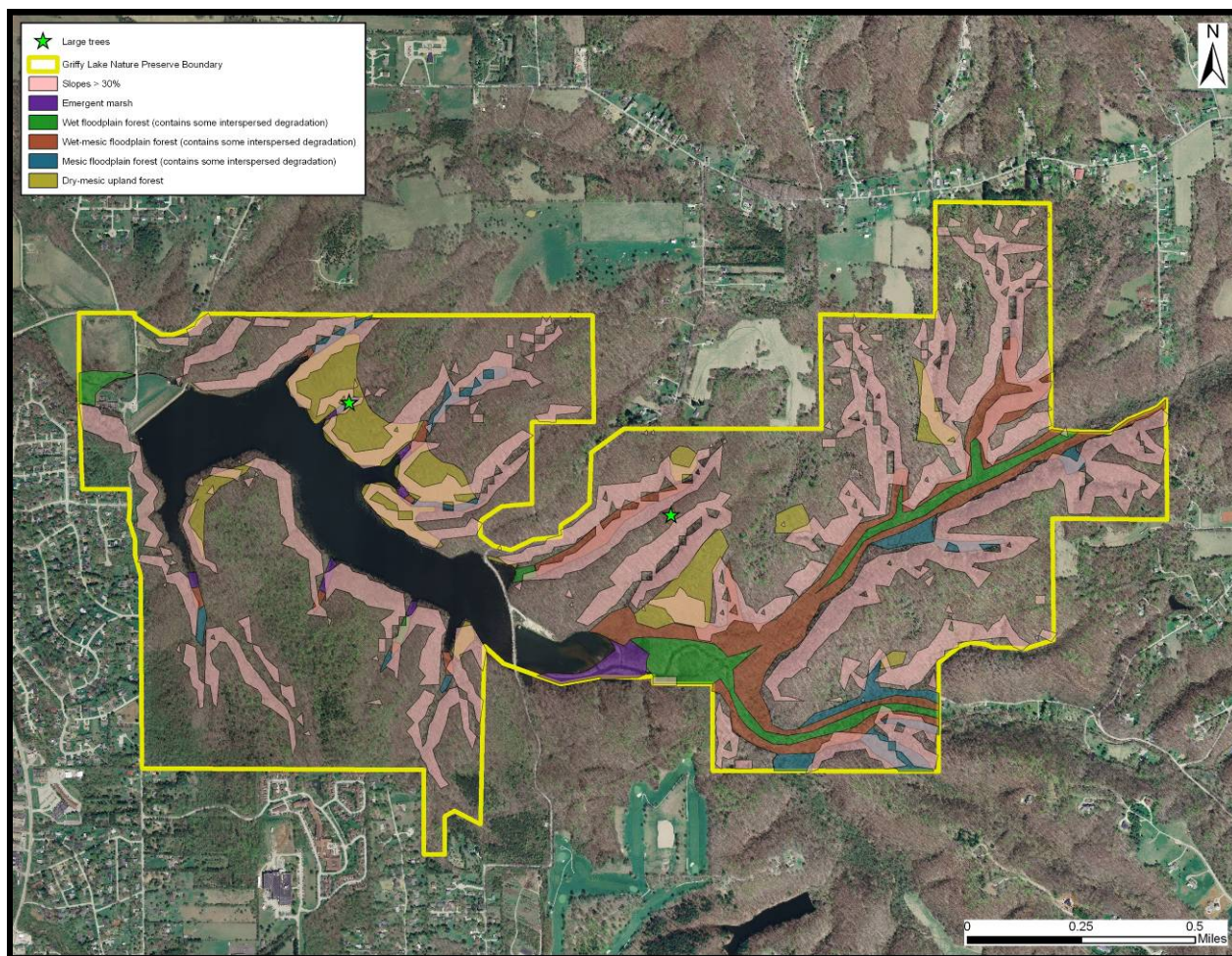


Figure 29. Sensitive Habitat Areas mapped in Griffy Lake Nature Preserve.

Slopes of greater than 30% are found throughout the site and are mostly correlated with steep ravines leading into Griffy Creek and Griffy Lake. These slopes generally are comprised of Mesic Upland Forest and Dry-Mesic Upland Forest. In some places, the slopes consist of exposed bedrock with very little to no soil present. The steep slopes are considered Sensitive Habitat Areas because of their potential for further erosion. Where soil is shallow and bedrock is exposed, a unique community is created that often is comprised of uncommon and specialist plant species. It is recommended that these areas be avoided to the extent possible. Trails should be constructed away from the steep slopes, both for safety of hikers and to avoid destroying the sensitive habitat. If trails are constructed from the uplands to Griffy Creek or Griffy Lake, they should be constructed in areas where the slope is less than 30%.

Emergent Marsh is a wetland community found at several locations in low ground around the perimeter of Griffy Lake. Another area of Emergent Marsh (not mapped) is located west of Griffy Lake; this area is not directly adjacent to Griffy Lake or Griffy Creek and appears to have been restored to wetland recently, and is therefore not included as a Sensitive Habitat Area. Of the Emergent Marsh areas that are Sensitive Habitat Areas, the largest area is at the east end of Griffy Lake where Griffy Creek becomes Griffy Lake. Smaller Emergent Marsh areas are located at the bottoms of ravines adjacent to Griffy Lake. All of these areas are considered Sensitive Habitat Areas because they are directly adjacent to the creek and lake. Any disturbance to these areas will lead to increased sediment loading into Griffy Creek and Griffy Lake.

Lake, which would negatively impact fish and macroinvertebrate populations. These areas are also habitat for a variety of wildlife including wading birds, shorebirds, songbirds, and amphibians. Finally, Emergent Marsh filters runoff before it enters Griffy Creek and Griffy Lake. It is recommended that disturbance to these Sensitive Habitat Areas be avoided. If trails are to be constructed into or through the Emergent Marsh communities, boardwalks or viewing platforms are recommended to minimize disturbance. In addition, wetlands adjacent to navigable waterways are regulated by the United States Army Corps of Engineers (Corps), and any impacts to the Emergent Marsh would require authorization from the Corps prior to work.

Floodplain Forest is located along the length of Griffy Creek and in ravines leading into Griffy Lake. The Floodplain Forest has been divided into three communities based on hydrologic regime: Wet Floodplain Forest, Wet-Mesic Floodplain Forest, and Mesic Floodplain Forest. All three of these communities are considered Sensitive Habitat Areas because Griffy Creek overflows into these communities during high flow events. Disturbance to these communities would lead to increased sediment loading into Griffy Creek, negatively impacting fish and macroinvertebrate populations. In addition, large-seeded mercury (State Rare plant species) and butternut (State Watch List tree) are located throughout this area. Exotic and invasive species are also present throughout the Floodplain Forest, and control of these undesirable species is recommended. Aside from control work, it is recommended that this Sensitive Habitat Area be avoided.

Dry-Mesic Upland Forest is present on upper slopes and terraces throughout the site. In many cases, this community is present on slopes of greater than 30%. Therefore, this community is considered a Sensitive Habitat Area for the same reasons as the slopes of greater than 30%. In addition, the Dry-Mesic Upland Forest is being encroached upon by Mesic Upland Forest as natural succession takes place. As succession continues, plant species found only in the Dry-Mesic Upland Forest community will be lost. It is recommended that the steep slope portions of this community be avoided; however, trails leading through the portions of this community with a less steep slope could be constructed. Preservation of this community could be achieved by selective tree removal or by prescribed burning.

Two areas north of Griffy Lake and Griffy Creek were noted as having large trees present. These areas are within the Mesic Upland Forest and Dry-Mesic Upland Forest communities. The large tree areas are considered Sensitive Habitat Areas because of the presence of large trees. Much of the Griffy Lake Nature Preserve has been logged relatively recently, but there is no evidence of logging in these two locations. It is recommended that these areas be preserved. Trails through these areas would not directly negatively impact the areas.

5.3 Land Acquisition Recommendations

With a primary goal of the GLNP being to preserve the natural resources of the property for use and enjoyment by Bloomington and Monroe County residents, it is important that the managers of the property proactively pursue opportunities that could contribute to the long-term preservation. Adjacent properties that are likely to undergo land use changes with potentially negative impacts to GLNP should be considered as an acquisition opportunity for the BPR. Likewise, when any adjacent properties are listed for sale, the BPR should make a determination on a case-by-case basis about whether the property is critical enough to purchase and add to the nature preserve. Some variables that might be considered when making these decisions are: price, likelihood of dense development in the future, natural features, possibility of connectivity with other city or county facilities, and other specific intentions of the seller.

In general, it is recommended that serious consideration for acquisition be given to properties along the northern and eastern borders of the property. These properties are still rural and are generally in their natural state. They would contribute to the mission of GLNP by widening the buffer for protected land around the lake, and adding additional recreational opportunities and possibly more access to the property for recreational users. Finally, the Bloomington Environmental Commission recommends that the BPR develop an inventory of undeveloped land parcels in the Griffy Lake watershed. Secondly, the EC suggests that a monitoring system and strategy be developed for acquisition of key parcels within the watershed and that a fund be created to allow for timely acquisition of parcels as they become available.

5.4 Acquisition Alternatives

Land managers have a variety of tools that can be used to acquire and protect property for preservation, access, right-of-way, or other purposes. In the case of GLNP, as explained in the previous section, likely reasons for acquiring property would be to widen the protective buffer of land around the lake to maintain or improve its ecological sustainability, to gain additional access, or to provide recreational opportunities. Besides the outright fee simple purchase of land when it becomes available for sale, there are several other options that should be considered. These options are described below:

Land Donations occur when a landowner wants to see land preserved and entitle the previous owner to deduct the appraised value of the land from his or her taxes. Developers have utilized this method, as it allows them to donate and preserve portions of property that have development constraints.

Conservation Easements is a contract between a landowner and the city that limits activities on the land now and in the future while the landowner maintains title to the land itself. Conservation easements can be tailored to the property and wishes of the donor to cover only certain activities or areas. The process requires work by the donor and the city to develop the exact contract required. A conservation easement is potentially difficult for the city in the long run, as it must establish a relationship with each new owner and educate them as to the restrictions on the property.

There are two advantages to conservation easements. First, the landowner can take a deduction from their federal income tax for a charitable contribution for the difference in appraised value of the property before and after the easement is granted. Second, an easement reduces the inheritance tax that the landowner's heirs will have to pay upon inheriting the property.

Life Estates are used by landowners who want to continue to use their property during their lifetime but want to ensure that their preservation wishes are carried out after their death. The property can be deeded to the city but the landowner continues to have full use of the property during his or her lifetime.

Charitable Remainder Trust is when the donor promises to give the title to the property to the city upon their death. The donor retains the title to the property until that time. The advantage of this technique over a will is that a tax deduction can be taken for the contribution. The deduction will be less than an outright donation, because the IRS deducts the value the donor receives from owning the property for the rest of their life. This is determined through statistical tables that depend on the landowner's age.

5.5 Nature Preserve Classification Review and Expansion

Currently, only the southwest corner of the Griffy Lake Nature Preserve (with the exception of small parcels at the far southwest corner) is dedicated as State Nature Preserve by the Indiana Department of Natural Resources – Division of Nature Preserves (IDNR-DNP; Figure 30). IDNR personnel indicate that one reason that only this area was originally selected was that Winona Welch, a local naturalist, studied this area extensively and documented its high natural area quality in the early 1900s (Lee Casebere, personal communication). The current study shows that high natural area quality is present throughout the site, and that a larger area would likely be dedicated as State Nature Preserve by the IDNR-DNP if so desired.

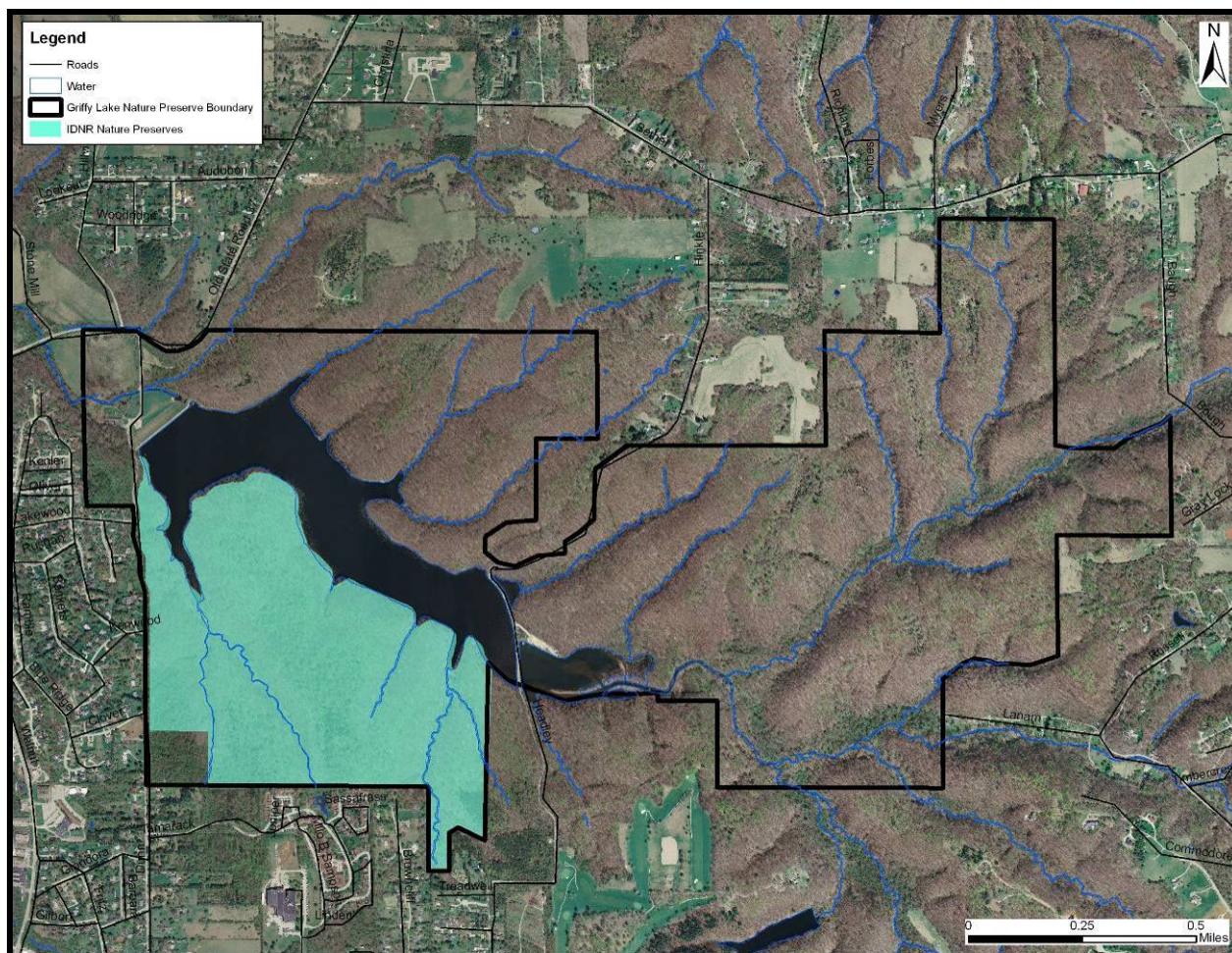


Figure 30. Existing dedicated State Nature Preserve boundaries within the Griffy Lake Nature Preserve.

As will be detailed in subsequent sections, the GLNP harbors more than 560 vascular plant species, of which approximately 82% are native to Indiana. The mean C value for the site as a whole is 3.2 and the FQI is 77.0. (Please refer to the **Natural Resources Inventory Section** for an explanation of these values.) These values include the 99 non-native plant species observed at the site. (Non-native plant species automatically receive C values of 0.) When only the native species observed are included, the mean C value is 3.9. Many high quality plant species are present throughout the site; 71 species with C values greater than or equal to 7 were observed. Natural plant communities are present throughout the 1,180 acres, with Wet Floodplain Forest, Wet-Mesic Floodplain Forest, and Mesic Floodplain Forest found mostly in the eastern half of the site, and Mesic Upland Forest and Dry-Mesic Upland Forest located throughout the site. In

addition, rare plants (State Rare and State Watch List) are present throughout the site. Large-seeded mercury, blue curls, and wild sensitive plant are found in the eastern half of the site. Spotted wintergreen is present in the northeast corner of the site. Butternut is scattered in the southeast portion of the site. Horned pondweed is found at the east end of Griffy Lake. Golden seal, Illinois wood sorrel, and ginseng are all present in the western half of the site. Oval ladies tresses and synandra are also present at various locations throughout the site. It is difficult to identify any specific portions of the site that are of higher quality than the rest of the site. Exotic and invasive species are present in defined areas around the perimeter of the site, adjacent to roads, adjacent to development, in areas that were historically cleared and are beginning to reforest naturally, and in areas prone to natural disturbance such as flooding.

Wildlife is also abundant at the study site. Nineteen species of mammals, nearly 160 bird species, and greater than 20 species of reptiles and amphibians were observed using the property during the current study. Of these species, one bird species of global conservation concern, nine birds of continental conservation concern, ten birds of regional conservation concern, and eight bird species listed as Endangered, Threatened, Rare, or Special Concern in Indiana were observed. Additionally, most of these were observed breeding or are considered likely to be breeding on the site. Among these is the Cerulean Warbler, a species of global conservation concern, which was found breeding along Griffy Creek to the east of the lake.

Overall, the Griffy Lake Nature Preserve consists of several natural plant communities with relatively high natural area quality, high vascular plant species richness, the presence of several rare plant species, fairly defined areas of exotic and invasive plant species, and a diversity of wildlife. For these reasons, it is recommended that Bloomington Parks and Recreation work with the IDNR Division of Nature Preserves to expand the portion of the Griffy Lake Nature Preserve that is protected by being state-dedicated nature preserve.

6.0 NATURAL FEATURES INVENTORY

The natural features inventory included efforts to inventory the native and exotic vegetation; inventories of the mammal, bird, reptile, and amphibian communities present at the Griffy Lake Nature Preserve; an evaluation of soil erosion issues at GLNP; and an assessment of habitat types and locations within GLNP. Native and exotic vegetation and habitat types and locations are detailed in the Natural Community Survey, while mammal, bird, and herp (reptiles and amphibians) surveys are detailed in subsequent sections. Erosion issues are cataloged in the Soil Erosion Survey which included identification of property-wide, stream-associated, and shoreline erosion issues within Griffy Lake Nature Preserve.

6.1 Natural Community Survey

The natural community survey consisted of a native and exotic vegetation survey and habitat assessment of Griffy Lake Nature Preserve. A field investigation was conducted to map the ecological communities, to inventory native and exotic vegetation, and to identify plant species listed as Endangered, Threatened, or Rare (ETR) by the Indiana Department of Natural Resources (IDNR). The field investigation was conducted during several site visits throughout the 2007 growing season.

As previously detailed, the site is located near the boundary of the Mitchell Karst Plain and the Brown County Hills Sections of the Highland Rim Natural Region (Homoya et al., 1985). The Mitchell Karst Plain Section is characterized by the karst plain, which is relatively level, although limestone cliffs and rugged hills are present in some areas, especially near the periphery of the section. Soils are generally well-drained silty loams derived from loess and weathered

limestone. The karst plain contains caves, sinkhole ponds and swamps, flatwoods, barrens, limestone glades, and several upland forest types, including the western mesophytic forest dominated by white oak (*Quercus alba*), sugar maple (*Acer saccharum* s. *saccharum*), shagbark hickory (*Carya ovata*), and pignut hickory (*C. glabra*), and the xeric forest dominated by post oak (*Quercus stellata*), chinquapin oak (*Q. muhlenbergii*), and blue ash (*Fraxinus quadrangulata*); mountain chestnut oak (*Q. montana*) is uncommon in this section. The Brown County Hills Section is characterized by deeply dissected uplands whose forests are dominated by oak-hickory, especially chestnut oak, and ravines with mesic species such as American beech (*Fagus grandifolia*), northern red oak (*Q. rubra*), sugar maple, and white ash (*F. americana*). Soils are generally well-drained acid silt loams with minor amounts of loess.

The plant communities at the site fit best into the description of the Brown County Hills Section. Steep ravines and flat plateaus characterize the site. Floodplains are present along the creek channels. Oak-hickory and beech-maple forests dominate the slopes and uplands. As previously detailed, eleven soil units are present on the Grippy Lake Nature Preserve. Thomas (1981) details that the soils can generally be grouped into three categories: soils formed in alluvium; soils formed in sandstone, siltstone, and shale residuum; and soils formed in limestone residuum. In general, the soils formed in alluvium are present in the floodplains, the soils formed in sandstone, siltstone, and shale residuum are present on the steep slopes, and the soils formed in limestone residuum are present on the terraces (Figure 5). Because of the chemical makeup of underlying substrate and soil forming processes, soils formed in sandstone, siltstone, and shale residuum are shallow, dry, and acidic in nature, while those formed in limestone residuum are generally deeper, more moist, and neutral or alkaline. The soil chemistry has influenced the formation of the vegetation communities on the site; hydrophytic and disturbance-tolerant plant species are present in the alluvial floodplain, dry-mesic species and acidophiles are present in the sandstone, siltstone, and shale soils on the steep slopes, and mesic species and calciphiles are present in the limestone soils on ridges. The presence of these three groups of soils on the site has led to high plant species richness.

6.1.1 Methodology

Prior to the site investigation, an Endangered, Threatened, and Rare (ETR) species query for the project area was submitted to the IDNR Division of Nature Preserves Natural Heritage Database. In addition, the IDNR website (IDNR-DNP, accessed April 2007) was consulted to generate a list of ETR plant species known to occur in Monroe County. The information received in response to these queries is included in Appendix A. Seventeen ETR vascular plant species appear on the Monroe County list; three of these species appear on the list generated by the IDNR for the project area.

A total of 260.5 person-hours were spent investigating the site on May 1 through 3, July 25 and 26, and September 12 through 14, 2007. Additional time was spent in the office identifying unknown plant species. The on-site investigation was conducted by teams of two individuals using meander survey methodology, zig-zagging across all portions of the project area. During the meander surveys, all vascular plant species observed were recorded (Appendix B). Plant communities were mapped across the site; within each community, representative photographs were taken and dominant species were noted. A search was conducted for ETR plant species during each field survey. For each ETR species observed, the population was mapped and photographed, notes on the population size and vigor were recorded, and associate plant species were noted. Mapped locations of ETR species are not contained herein but were provided along with GPS coordinates and photographs in separate files to the Parks and Recreation Department. Finally, infestations of exotic and invasive plant species were mapped

and photographed, and notes regarding size and threat to native communities were recorded on the infested areas.

Botanical nomenclature and acronyms, both in the text and in the species inventories, are taken from Rothrock (2004), which references both the Flora of North America Editorial Committee, eds. (1993+) and the Biota of North America database for nomenclature. The Floristic Quality Assessment (Rothrock, 2004) computer program (Conservation Research Institute/Conservation Design Forum, 1999; Indiana Database) was used to compile the 2007 species inventory. Rothrock (2004) assigns each native plant in Indiana a Coefficient of Conservatism value (C value) from 0 to 10, which is a measure of its ability to withstand degradation. Plants with C values of 10 are typically the first to be lost from a site when the site begins to become degraded. Conversely, plants with C values of 0 can withstand a large amount of degradation. The mean C value was determined by averaging the C values of all species identified on the site. The Floristic Quality Index (FQI) is a function of both the C value and the number of species observed at the site.

The Master Plant Species List (Appendix C) was compiled by adding the 2007 species inventory to previous botanical reports for the site; nomenclature is based on Rothrock (2004) and the Natural Resources Conservation Service (NRCS) Plants Database. The likelihood of species listed in previous botanical reports being present on the site was assessed; comments regarding this assessment on the Master Species List are based on information obtained from the NRCS Plants database (NRCS, accessed January-February 2008), Yatskievych (2000), and Jackson (2004).

6.1.2 Plant Inventory

A total of 564 vascular plant species were identified at the Griffy Lake Nature Preserve in 2007, with an additional 11 species identified only to genus and one species listed as an unidentifiable fern (Appendix X). In total, 82% (465 of 564) of the species identified are native to Indiana. The mean C value at the site was 3.2, and the FQI value was 77.0. Rothrock (2004) states that “an intact site accommodating the wide array of species characteristic of a pre-settlement plant community would have a mean C of 5 or greater,” and that “an old field or highly degraded sites (Wilhelm et al., 2003) might be expected to have Mean C values of 2 or less.” 13% (71 of 564) of the species identified have C values of 7 or greater. According to Rothrock (2004), plants with C values of 7 or 8 are “found in high-quality remnant plant communities but appear to endure, from time to time, some disturbance,” and those with C values of 9 or 10 are “restricted to remnant landscapes that appear to have suffered very little post-settlement trauma.”

The Master Plant Species List (Appendix X) is a list of all vascular plant species identified at the site during historical botanical studies at the site, including the species observed in 2007. Several species on the historic lists are not known to occur in Indiana, while other species were identified by historic names (synonyms) for species included in the 2007 inventory of the site. The Master Plant Species List incorporates updated botanical nomenclature and includes comments about plant species recorded during historic studies that are not likely to occur on the site.

6.1.3 Ecological Communities

Ten distinct ecological communities were mapped at the site (Figure 31). Several of the communities contained several variants, which were similar enough to each other to be grouped into the same community; the communities and variants are described below. Several of these communities fit within natural community type descriptions published in Jacquart et al. (2002),

although they may not be consistent with the minimum size requirements for classification by the State as a natural area. These communities are noted with an asterisk (*) below.

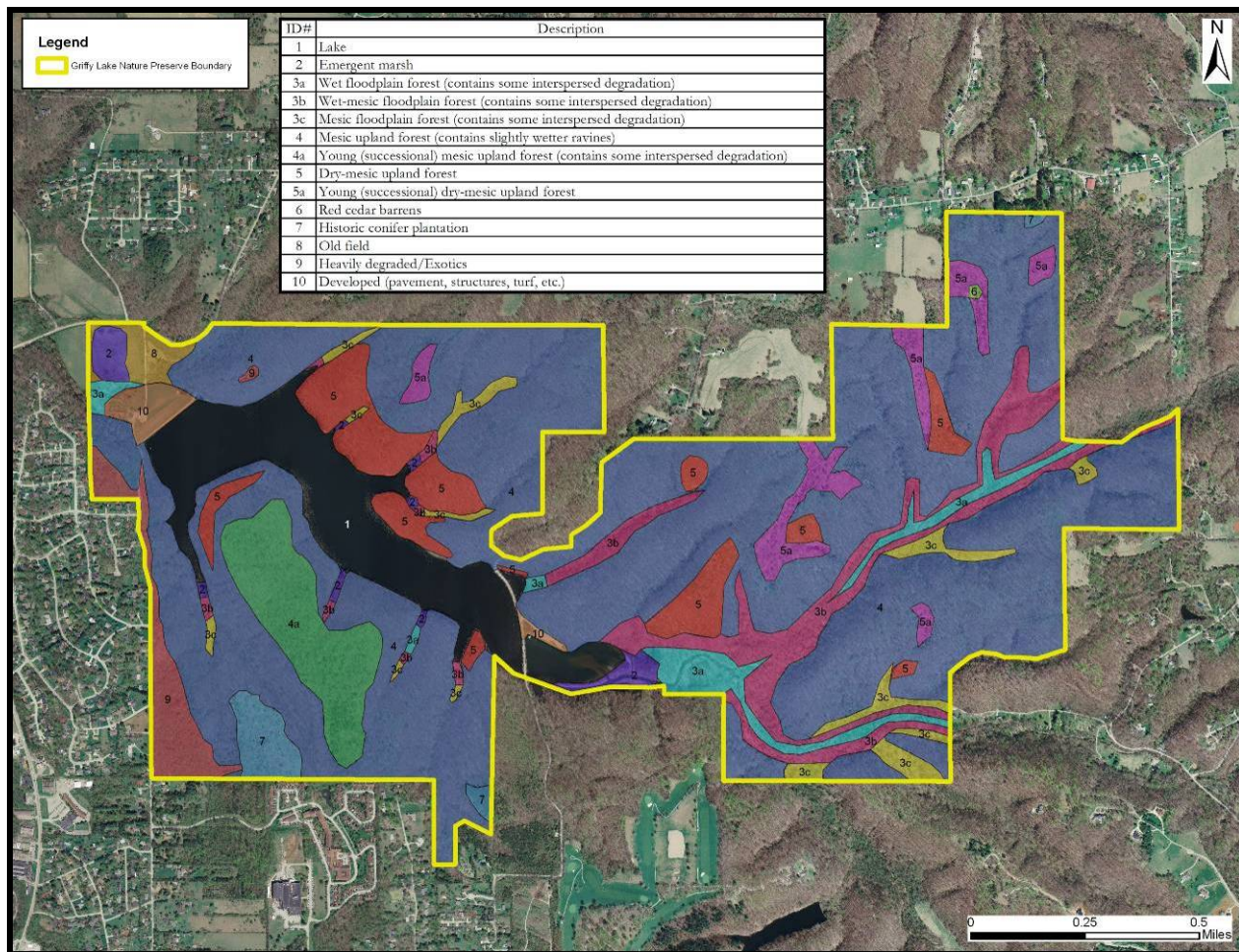


Figure 31. Plant communities mapped at Griffy Lake Nature Preserve, May, June, and September 2007.

Community 1: Lake (109 acres)



This community type is characterized by the presence of permanent open water. The Lake community, which is located through the middle of the western half of the site, is a man-made water body that was created by damming Griffy Creek. Casual observations of plant species within the Lake community were recorded, but a detailed inspection was not conducted as part of the botanical inventory.

Community 2: Emergent Marsh (13.9 acres)

This community type is characterized by the presence of wetland soils and hydrology, and emergent, herbaceous wetland vegetation. The Emergent Marsh community was observed adjacent to Griffy Lake in the bottoms of some of the ravines, at the eastern end of Griffy Lake, and in one location in a depression in an old field in the northwest corner of the site. This community was dominated by swamp milkweed (*Asclepias incarnata*), swamp tickseed (*Bidens comosa*), common hop sedge (*Carex lupulina*), cinnamon willow herb (*Epilobium coloratum*), marsh fleabane (*Erigeron philadelphicus*),



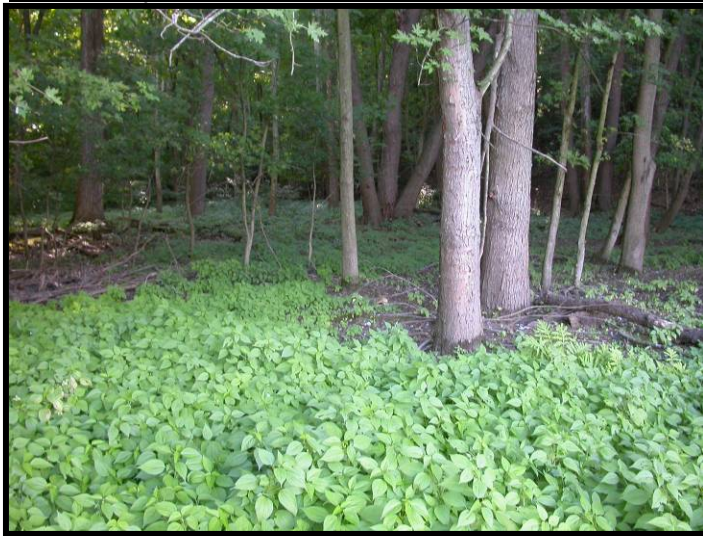
spotted Joe Pye weed (*Eupatoriadelphus maculatus*), common rush (*Juncus effusus*), rice cut grass (*Leersia oryzoides*), common water horehound (*Lycopus americanus*), moneywort (*Lysimachia nummularia*), creeping smartweed (*Persicaria caespitosa*), mild water pepper (*P. hydropiperoides*), smartweed (*P. punctatum*), arrow-leaved tear-thumb (*P. sagittata*), wool grass (*Scirpus cyperinus*), and hybrid cattail (*Typha x glauca*). Scattered black willow (*Salix nigra*) trees were present at some

locations, particularly in the transition between Emergent Marsh and Wet Floodplain Forest at the east end of Griffy Lake. This is a community type of moderate natural area quality.

Community 3: Floodplain Forest* (135.3 acres)

This community type is characterized by the presence of trees along a stream. Periodic flooding causes a natural disturbance that selects for early successional plant species and species that can tolerate changing conditions. The Floodplain Forest community was observed along the bottoms of some of the wider ravines, and in one location downstream of the dam in the northwest corner of the site. The Floodplain Forest community was split into three variants: Wet Floodplain Forest, Wet-Mesic Floodplain Forest, and Mesic Floodplain Forest. These variants are consistent with natural community type descriptions in Jacquart et al. (2002).

Community Variant 3a: Wet Floodplain Forest* (31.7 acres)



This community is a variant of the Floodplain Forest community in which flooding occurs very frequently, or where floodwaters persist for a long duration. These factors lead to a more open overstory and a denser herbaceous layer than in the other two variants of the Floodplain Forest community. The Wet Floodplain Forest was found along the lowest elevation terraces along creek channels in the eastern half of the site, along Griffy Creek west of the dam in the northwest corner of the site, and at several locations in ravines leading into Griffy Lake. Dominant trees observed at

various locations in this community included box elder (*Acer negundo*), silver maple (*Acer saccharinum*), sycamore (*Platanus occidentalis*), eastern cottonwood (*Populus deltoides*), black willow, and American elm (*Ulmus americana*). The understory in this community was dominated by false nettle (*Boehmeria cylindrica*), ground ivy (*Glechoma hederacea*), Canada wood nettle (*Laportea canadensis*), hairy spicebush (*Lindera benzoin*), Nepalese browntop (*Microstegium vimineum*), clearweed (*Pilea pumila*), creeping smartweed, and Japanese rose (*Rosa multiflora*). This community contains numerous small pockets of degraded areas due to the presence of exotic invasive species, but is regardless a community type of moderately high natural area quality.

Community Variant 3b: Wet-Mesic Floodplain Forest* (76.9 acres)

This community is a variant of the Floodplain Forest community in which flooding occurs somewhat frequently. Moisture levels in this community lie between those of the other two variants of the Floodplain Forest community. This variant represents a transition between the Wet and Mesic Floodplain Forests, and typically contains a mixture of wet and mesic tree species. The Wet-Mesic Floodplain Forest was found along the middle elevation terraces along creek channels in the eastern half of the site, and at several locations in ravines leading into Griffy Lake. Dominant tree species observed at various locations in this community included silver maple, Ohio buckeye (*Aesculus glabra*), black walnut (*Juglans nigra*), tulip poplar (*Liriodendron tulipifera*), sycamore, wild black cherry (*Prunus serotina*), American elm, and slippery elm (*Ulmus rubra*). Common understory shrubs were leatherwood (*Dirca palustris*), common privet (*Ligustrum vulgare*), hairy spicebush, and Japanese rose. Poison ivy

(*Toxicodendron radicans* s. *radicans*) was common in the vine stratum. The herbaceous understory of the Wet-Mesic Floodplain Forest was dominated by garlic mustard (*Alliaria petiolata*), hog peanut (*Amphicarpaea bracteata* v. *bracteata*), Virginia bluebells (*Mertensia virginica*), Nepalese browntop, golden ragwort (*Packera aurea*), clearweed, creeping smartweed, Virginia knotweed (*Tovara virginiana*), and wingstem (*Verbesina alternifolia*). This community contains some extensive pockets of degraded areas due to the presence of exotic invasive species, and is therefore a community type of moderate natural area quality.



Community Variant 3c: Mesic Floodplain Forest* (26.7 acres)



This community is a variant of the Floodplain Forest community in which soils are not as wet as in the other two variants. The Mesic Floodplain Forest was found at the highest elevation of the floodplain along ravines throughout the site, where it transitions into the Mesic Upland Forest community. Dominant tree species observed at various locations in this community included sugar maple, papaw (*Asimina triloba*), black walnut, tulip poplar, black cherry, and American elm. The understory of the Mesic Floodplain Forest was dominated by garlic mustard, various sedges (*Carex* spp.), wild geranium (*Geranium maculatum*),

and Japanese rose. This community contains pockets of degraded areas, and is therefore a community type of moderate natural area quality.

Community 4: Mesic Upland Forest* (702.4 acres)

This community type was the most extensive of the plant communities identified. The Mesic Upland Forest is typically known as the climax community in the successional process. The area covered by this community is increasing as organic matter accumulates within the Dry-Mesic Upland Forest, creating deeper, cooler, and moister soils. The Mesic Upland Forest community is characterized by low levels of disturbance and the presence of very few exotic species. Very large trees were observed in some areas within this community, such as the north central portion of the western half of the site and the northwestern portion of the eastern half of the site. The Mesic Upland Forest community was observed within a wide range of topography, from ridges to steep slopes and bottoms of ravines. The over story was dominated by sugar maple, Ohio buckeye, American beech, white ash, tulip poplar, wild black cherry, and

northern red oak. In some locations, particularly in areas of transition between Mesic Upland Forest and Dry-Mesic Upland Forest, red maple (*Acer rubrum* v. *rubrum*), white oak, and black oak (*Quercus velutina*) were also among the dominant tree species. The herbaceous layer of this community type varied across different portions of the site. In some places, the herbaceous layer was sparse, especially during the July and September site visits. Ephemeral woodland wildflowers were abundant during the May site visit. Herbaceous species commonly seen included wild ginger (*Asarum canadense*), squirrel



corn (*Dicentra canadensis*), yellow adder's tongue (*Erythronium americanum*), twinleaf (*Jeffersonia diphylla*), round-leaved ragwort (*Packera obovata*), and celandine poppy (*Stylophorum diphyllum*). Sedges were also dominant in the Mesic Upland Forest community. Those seen most frequently included blunt-scaled wood sedge (*Carex albursina*), grass sedge (*Carex jamesii*), and weak-stemmed wood sedge (*Carex laxiculmis* v. *laxiculmis*). The bottoms of the narrower ravines within this community, while not characterized as floodplains, contained some typical floodplain species, such as sycamore, false nettle, and feathery false Solomon's seal (*Maianthemum racemosum*), in addition to many of the dominant species listed above. Some areas within this community also contained autumn olive (*Elaeagnus umbellata*), common privet, amur honeysuckle (*Lonicera maackii*), Morrow's honeysuckle (*L. morrowii*), black locust (*Robinia pseudoacacia*), Japanese rose, and periwinkle (*Vinca minor*) among the dominant species. However, the areas dominated by exotic species are relatively small in the Mesic Upland Forest community, and this community type is generally of high natural area quality.

Community Variant 4a: Young (Successional) Mesic Upland Forest (52.4 acres)



This variant of the Mesic Upland Forest community is characterized by higher levels of disturbance, smaller over story trees, and the common occurrence of exotic/invasive plant species. The Young Mesic Upland Forest community was observed on the upper slopes of a large ridge in the southwest portion of the site, in an area that had been previously mapped as an old-field community (Jones et al. 1984). In the 23 years since the previous classification, the old-field community has been undergoing the process of succession into Mesic Upland Forest. The over story of this community was

dominated by sugar maple and northern red oak. The shrub and herbaceous layers were dominated by sugar maple seedlings, autumn olive, May apple (*Podophyllum peltatum*), and Japanese rose. This is a community type of moderately low natural area quality.

Community 5: Dry-Mesic Upland Forest* (71.1 acres)

This community type is characterized by drier, shallower soils than those found in the Mesic Upland Forest, and by plant species adapted to them. The Dry-Mesic Upland Forest community was observed along various upper slopes and terraces throughout the site; on some slopes, soils were completely lacking and rocky outcrops were present. The amount of Dry-Mesic Upland Forest at the site is decreasing as successional processes move the community to Mesic Upland Forest. The over story of the Dry-Mesic Upland Forest was dominated by pignut hickory, American beech, eastern red cedar (*Juniperus virginiana*), white oak, and black oak. In some locations, red maple, sugar maple, chinkapin oak, and northern red oak were also common. Mountain chestnut oak was present in the driest portions of this community, in an environment grading toward that of an Dry Upland Forest community, although no Dry Upland Forest was identified on the site. Dominant understory tree and shrub species included flowering dogwood (*Cornus florida*), cat brier (*Smilax rotundifolia*), and late low blueberry (*Vaccinium pallidum*). The herbaceous layer was dominated by autumn bent grass (*Agrostis perennans*), common pussy toes (*Antennaria plantaginifolia*), Pennsylvania oak sedge (*Carex pensylvanica*), painted sedge (*Carex picta*), poverty oat grass (*Danthonia spicata*), shining bedstraw (*Galium concinnum*), and lion's foot (*Prenanthes alba*). Pennywort (*Obolaria virginica*) was also common in some locations. Exotic and invasive plant species were mostly lacking from the Dry-Mesic Upland Forest community. This is a community type of high natural area quality.



Community Variant 5a: Young (Successional) Dry-Mesic Upland Forest (32.8 acres)



This variant of the Dry-Mesic Upland Forest contains smaller over story trees and a greater level of recent disturbance; in addition, oaks are absent from the over story. The Young Dry-Mesic Forest was observed along a ridge in the northwestern portion of the site and along several ridges in the eastern half of the site. Several of the areas identified as Young Dry-Mesic Upland Forest were previously mapped as old-field (Jones et al. 1984). In the 23 years since the previous classification, the old-field areas have been undergoing the process of succession into Dry-Mesic Upland Forest.

The over story was dominated primarily by red cedar (*Juniperus virginiana*); in some areas, the red cedar trees were large and dying. Black gum (*Nyssa sylvatica*) and sassafras

(*Sassafras albidum*) trees were also dominant in the over story at some locations. The understory was dominated by flowering dogwood, red maple, tulip poplar, and sassafras saplings. The herbaceous layer was dominated by common wood sedge (*Carex blanda*), Pennsylvania oak sedge, hairy wild licorice (*Galium circaezans* v. *hypomalacum*), and woolly blue violet (*Viola sororia*). The Young Dry-Mesic Upland Forest community contained several small open pockets with greater diversity and cover of herbaceous species, which were similar in understory composition to the Red Cedar Barrens community. This community also contained some autumn olive and Japanese rose, and is therefore of moderate natural area quality.



Community 6: Red Cedar Barrens (0.5 acre)



This community type is characterized by soil moisture similar to that of the Dry-Mesic Upland Forest, but over story trees are absent and the understory is dense with mostly herbaceous species. The Red Cedar Barrens community was observed in one small location on a ridge in the northeast corner of the property. This community was typically surrounded by Young Dry-Mesic Upland Forest and may represent an earlier successional stage of this community. Small scattered red cedar trees were present in the Red Cedar Barrens community, but the dominant plant species were herbaceous: stiff tick trefoil (*Desmodium obtusum*), hairy

bush clover (*Lespedeza hirta*), little bluestem grass (*Schizachyrium scoparium*), and old-field goldenrod (*Solidago nemoralis*). Some form of disturbance, possibly anthropogenic in nature, must have occurred fairly recently to prevent the growth of trees and shrubs in this area; however, the plant community consisted mostly of native species. This community is of moderate natural area quality.

Community 7: Historic Conifer Plantation (15.9 acres)

This community type is characterized by planted conifers with a hardwood and/or herbaceous understory. The Historic Conifer Plantation community was observed on flatter areas on two ridges in the southwest portion of the site, and also adjacent to developed private property at the far northeast corner of the site. In the southwest portion of the site, the overstory in the Historic Conifer Plantation community was dominated by white pine (*Pinus strobus*). Hardwoods observed include sugar maple and tulip poplar, and red cedar was present. The

shrub layer was dominated by Japanese honeysuckle (*Lonicera japonica*) and Japanese rose, and the herbaceous layer was dominated by May apple. In the northeast corner of the site, the overstory in the Historic Conifer Plantation was dominated by Scotch pine (*P. sylvestris*) and scrub pine (*P. virginiana*). Other trees present included red maple, flowering dogwood, red cedar, and sassafras. The understory was dominated by long-awned wood grass (*Brachyelytrum erectum*) and white ash seedlings. This is a community type of moderately low natural area quality.



Community 8: Old Field (9.6 acres)

This community type is characterized by an herbaceous layer dominated by grasses and other typical old-field species. This community has arisen as a result of recent anthropogenic disturbances. The Old Field community was observed in a low flat area below the dam in the northwest corner of the site. Dominant plant species observed include giant ragweed (*Ambrosia trifida*), broom sedge (*Andropogon virginicus*), staghorn sumac (*Rhus typhina*), tall goldenrod (*Solidago altissima*), and tall ironweed (*Vernonia gigantea*). This community is of low natural area quality.

Community 9: Heavily Degraded / Exotics (27.9 acres)



This community type is characterized by high levels of disturbance and evidence of grazing, and a high proportion of exotic/invasive plant species. These factors have created a condition in which a natural plant community is no longer recognizable. The Heavily Degraded/ Exotics community was observed along much of the west property boundary, extending into the site somewhat at the southwest corner. A small pocket of the Heavily Degraded/ Exotics community was also noted within the Mesic Upland Forest Community north of Griffy Lake in the western half of the

site. The dominant species in this community were garlic mustard, autumn olive, amur honeysuckle, black locust, and Japanese rose. Scattered native species, including sugar maple, various sedges (*Carex* spp.), flowering dogwood, golden ragwort, and sassafras, were also observed. This is a community type of low natural area quality.

Community 10: Developed (11.6 acres)

This community type is characterized by the presence of manmade structures such as buildings, pavement, and the dam. Vegetated areas consisted of mowed turf. This community is located in two locations, on the northwest side of Griffy Lake, and on the east side of Hinkle Road north of Griffy Lake. Where vegetation was present, dominant plant species included English plantain (*Plantago lanceolata*), annual blue grass (*Poa annua*), Kentucky blue grass (*P. pratensis*), common knotweed (*Polygonum aviculare* v. *aviculare*), and white clover (*Trifolium repens*). This is a community type of very low natural area quality.



6.1.4 Endangered, Threatened and Rare Flora Species

Endangered, Threatened, and Rare plant species are tracked by IDNR. A fourth category of plants of concern is Watch List. To be listed as Endangered, there must be one to five occurrences of the plant statewide. Plant species with six to 10 known occurrences are listed as Threatened. Rare species are those with 11-20 known occurrences statewide. Watch List species include those that were previously on the ETR list but that have been removed, often because enough occurrences to surpass the Rare category exist. If a species is removed from the ETR list, it remains on the Watch List perpetually, unless there is a reason to move it back to the ETR list. Watch List species are not actively tracked by IDNR (Homoya, personal communication, February 2008).

No vascular plant species listed as Endangered or Threatened by IDNR were identified on the site. Five species listed as Rare were positively identified. Populations of 10 species on Indiana's Watch List were identified on the site; one additional Watch List species was observed just outside the site boundary. Of the 15 species of concern on the site, three represent species that were planted or have escaped from cultivation. The 15 ETR or Watch List species observed at Griffy Lake Nature Preserve are detailed in Table 3.

Six of the 15 ETR and Watch List species found at the site are on the list received in response to the query sent to the IDNR and the list of ETR and Watch List species known in Monroe County (IDNR-DNP, accessed April 2007). A post-fieldwork review identified nine additional species found at the site as ETR and Watch List species. Notes on these additional populations were minimal, and their locations were not surveyed in the field.

Three of the listed species found on the site, Cigar tree (*Catalpa speciosa*, State Rare), white pine (*Pinus strobus*, State Rare), and scrub pine (*Pinus virginiana*, State Watch List), are assumed to have been planted or are the result of reproduction from planted individuals. Both white pine and scrub pine were observed in plantations and were obviously introduced at the site. Cigar tree was historically present in a few counties in southwestern Indiana, but has now spread throughout the state due to being planted (Jackson, 2004); the individuals found at the site were not in natural plant communities.

Table 3. ETR/Watch list plant species observed at Griffy Lake Nature Preserve in 2007.

Scientific Name	Common Name	Conservation Status
<i>Acalypha deamii</i>	Large-seeded mercury	State Rare
<i>Catalpa speciosa</i>	Cigar tree	State Rare
<i>Chamaecrista nictitans</i>	Wild sensitive plant	State Watch List
<i>Chimaphila maculata</i>	Spotted wintergreen	State Watch List
<i>Hydrastis canadensis</i>	Golden seal	State Watch List
<i>Juglans cinerea</i>	Butternut	State Watch List
<i>Oxalis illinoensis</i>	Illinois wood sorrel	State Watch List
<i>Panax quinquefolius</i>	Ginseng	State Watch List
<i>Pinus strobus</i>	White pine	State Rare
<i>Pinus virginiana</i>	Scrub pine	State Watch List
<i>Spiranthes ovalis</i> v. <i>erostellata</i>	Oval ladies' tresses	State Watch List
<i>Synandra hispidula</i>	Synandra	State Watch List
<i>Trichostema dichotoma</i>	Blue curls	State Rare
<i>Viola pubescens</i>	Downy yellow violet	State Watch List
<i>Zannichellia palustris</i>	Horned pondweed	State Rare

Five populations of large-seeded mercury (*Acalypha deamii*, State Rare) were identified in the Wet-Mesic Floodplain Forest. The number of plants observed in each population ranged from



one to 15. Associate plant species included black maple (*Acer saccharum* s. *nigrum*), papaw, sedges, flowering dogwood, American beech, Kentucky coffee tree (*Gymnocladus dioica*), butternut (*Juglans cinerea*), Canada wood nettle, common privet, tulip poplar, creeping smartweed, Christmas fern (*Polystichum acrostichoides*), Japanese rose, Virginia knotweed, and slippery elm. This species has not been previously documented by IDNR in the Griffy Lake area, but it has been documented by IDNR in Monroe County. Large-seeded mercury has not been observed during any of the past studies at the site.

One population of few individuals of blue curls (*Trichostema dichotoma*, State Rare) was identified in an opening within the Young (Successional) Dry-Mesic Upland Forest. Associate plant species included spotted wintergreen (*Chimaphila maculata*), eastern red cedar, ox-eye daisy (*Leucanthemum vulgare*), red-stalked plantain (*Plantago rugelii*), an unidentifiable rose (*Rosa* sp.), and rose gentian (*Sabatia angularis*). Other trees were present but were not recorded as associate species. This species has not been previously documented by IDNR in either the Griffy Lake area or Monroe County. Blue curls has not been observed during any of the past studies at the site. According to Homoya (personal communication, February 2008), blue curls will soon be removed from the list of State Rare species and become a Watch List species.



Horned pondweed (*Zannichellia palustris*, State Rare) was identified on the edge of Griffy Lake. Formal surveys for this species were not conducted; it is possible that horned pondweed is present at various locations throughout the lake. Associate plant species included Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*). Horned pondweed has been previously documented by IDNR in Monroe County and in the Griffy Lake area. Aquatic Control (2007) documented the presence of horned pondweed in relatively low density during their August 6, 2006 aquatic plant survey. Aquatic Control also documented the presence of horned pondweed in the headwaters of Griffy Lake during informal surveys prior to aquatic plant treatment (Nate Long, personal communication).

Wild sensitive plant (*Chamaecrista nictitans*, State Watch List) was observed in scattered locations in canopy openings within the Young (Successional) Dry-Mesic Upland Forest. Associate plant species included common milfoil (*Achillea millefolium*), butterflyweed (*Asclepias tuberosa*), Queen Anne's lace (*Daucus carota*), round-leaved tick trefoil (*Desmodium rotundifolium*), purple love grass (*Eragrostis spectabilis*), rough hawkweed (*Hieracium scabrum*), hairy bush clover, old-field goldenrod, and common purpletop (*Tridens flavus*). Trees were present but were not recorded as associate species. This species has not been previously documented by IDNR in the Griffy Lake area or in Monroe County, but it was recorded in an undated Flora of Monroe County (Longmire and Meyer, no date).

Spotted wintergreen (State Watch List) was observed in scattered locations at the site, including in an opening within the Young (Successional) Dry-Mesic Upland Forest. Associate plant species included eastern red cedar, ox-eye daisy, red-stalked plantain, an unidentifiable rose, rose gentian, and blue curls. Other trees were present but were not recorded as associate species. This species has not been previously documented by IDNR in the Griffy Lake area or in Monroe County, but it was recorded in an undated Flora of Monroe County (Longmire and Meyer, no date). It has also been noted at the site in an undated inventory of Griffy Lake (Longmire and Meyer, no date), by Thiele (1982), by Huffman (undated), and by Blatchley (Meyer, personal communication August 2007).



One population of golden seal (*Hydrastis canadensis*, State Watch List) was identified within the Dry-Mesic Upland Forest community. The population consisted of several plants within an area of approximately 25 square feet. Associate plant species included wild garlic (*Allium canadense*), serviceberry (*Amelanchier* sp.), common wild yam (*Dioscorea villosa*), trailing ground pine (*Lycopodium digitatum*), bladdernut (*Staphylea trifolia*), and southern arrowwood (*Viburnum dentatum*). Trees were present but were not recorded as associate species. This species has not been previously

documented by IDNR in the Griffy Lake area, but it has been documented by IDNR in Monroe County. It has also been recorded in an undated Flora of Monroe County (Longmire and Meyer, no date), in an undated inventory of Griffy Lake (Longmire and Meyer, no date), in an undated floristic inventory of Griffy Lake and Leonard Springs (Longmire and Meyer, no date), and by Huffman (undated).

Two large areas within the Floodplain Forest and Mesic Upland Forest Communities contained sparsely scattered individuals of butternut (State Watch List) mixed with black walnut. In addition, a single butternut tree was observed in the Wet-Mesic Floodplain Forest. Butternut trees ranging from 8-24 inches in diameter at breast height (DBH) were observed. In some locations, butternut fruits were noted on the ground, providing positive evidence of the presence of this species; definite identification of butternut trees in some locations could not be made, due to the similarity of this species to black walnut. Associate plant species included large-seeded mercury, black maple, white snakeroot (*Ageratina altissima*), papaw, false nettle (*Boehmeria cylindrica*), sedges, flowering dogwood, American beech, Kentucky coffee tree, great waterleaf (*Hydrophyllum appendiculatum*), Canada wood nettle, common privet, hairy spicebush (*Lindera benzoin*), tulip poplar, Nepalese browntop, creeping smartweed, Christmas fern, Japanese rose, Virginia knotweed, slippery elm, and wingstem (*Verbesina alternifolia*). This species appears on both the IDNR list of species documented in the Griffy Lake area and the IDNR list of species documented in Monroe County. It has also been noted on the site in an undated inventory of Griffy Lake (Longmire and Meyer, no date) on a vascular plant species list compiled for the preserve (anonymous, 1996), by Thiele (1982), and by Huffman (undated). Butternut was also recorded in an undated Flora of Monroe County (Longmire and Meyer, no date).



One population of Illinois wood sorrel (*Oxalis illinoensis*, State Watch List) was identified within the Mesic Upland Forest community. The population consisted of few plants. Associate species included blue cohosh (*Caulophyllum thalictroides*), climbing bittersweet (*Celastrus scandens*), bottlebrush grass (*Hystrix patula*), and Japanese rose. Trees were present but were not recorded as associate species. This species appears on the IDNR list of species documented in Monroe County, but has not been previously documented in the Griffy Lake area. It was also recorded in an undated Flora of Monroe County (Longmire and Meyer, no date).

One population of ginseng (*Panax quinquefolius*, State Watch List) was identified within the Mesic Upland Forest community. The population consisted of a single plant growing with mesic woods species, including green ash (*Fraxinus pennsylvanica* v. *lanceolata*), two-flower false dandelion (*Krigia biflora* v. *biflora*), bloodroot (*Sanguinaria canadensis*), bluestem goldenrod (*Solidago caesia*), and downy yellow violet (*Viola pubescens*). Other trees were present but were not recorded as associate species. This species appears on the IDNR list of species documented in Monroe County, but has not been previously documented by IDNR in the Griffy Lake area. It was, however, noted on the site in an undated inventory of Griffy Lake (Longmire and Meyer, no date), in an undated floristic inventory of Griffy Lake and Leonard Springs (Longmire and Meyer, no date), in a plant study at Griffy Lake and other State Parks and Nature Preserves (anonymous, 1995), by Thiele (1982), and by Huffman (Longmire and Meyer, no date). It is also included in an undated Flora of Monroe County (Longmire and Meyer, no date).



Oval ladies' tresses (*Spiranthes ovalis* v. *erostellata*, State Watch List) was observed at several locations throughout the site, primarily in the Mesic Upland Forest. Populations consisted of one to a few plants. Associate plant species included woodland brome (*Bromus pubescens*), sedges, Virginia waterleaf (*Hydrophyllum virginianum*), common privet, common cinquefoil (*Potentilla simplex*), poison ivy, and violets. Trees were present but were not recorded as associate species. This species does not appear on the IDNR list of species documented in the Griffy Lake area or in Monroe County, but it has been observed in Monroe County by Homoya (personal communication February 2008). It has not been observed in previous studies of the site.

Few individuals of synandra (*Synandra hispidula*, State Watch List) were observed at the site in Mesic Upland Forest. Associate plant species were not recorded. This species does not appear on the IDNR list of species documented in the Griffy Lake area or in Monroe County. It was, however, recorded in an undated Flora of Monroe County (Longmire and Meyer, no date), and it was noted on the site in an undated inventory of Griffy Lake (Longmire and Meyer, no date), by Huffman (undated), and by Blatchley (Meyer, personal communication August 2007).

Downy yellow violet (State Watch List) was observed commonly at the site throughout the Mesic Upland Forest. Associate plant species were not recorded. Downy yellow violet is included on the State Watch List because it once consisted of two separate species (*Viola pensylvanica* and *V. pubescens*). When it was considered a distinct species, *V. pensylvanica* was uncommon. However, because these species have been lumped together into *V. pubescens*, downy yellow violet was reduced to a State Watch List species (Homoya, personal communication February 2008). This species does not appear on the IDNR list of species documented in the Griffy Lake area or in Monroe County. It was noted on the site in an undated inventory of Griffy Lake (Longmire and Meyer, no date), by Thiele (1982), and by Huffman (undated).



In addition to the populations observed on-site, one population of five leaves (*Isotria verticillata*, State Watch List) was identified just outside the boundary of the site. The population consisted of approximately 30 widely scattered vegetative plants growing with red maple, sedges, flowering dogwood, American beech, and late low blueberry. This species has not been previously documented by IDNR in either the Griffy Lake area or Monroe County. It has, however, been noted on the site in an undated inventory of Griffy Lake (Longmire and Meyer, no date), in a plant study at Griffy Lake and other State Parks and

Nature Preserves (anonymous, 1995), by Huffman (undated), and by Blatchley (Meyer, personal communication August 2007). It was also recorded in an undated Flora of Monroe County (Longmire and Meyer, no date).

6.1.5 Exotic and Invasive Species

Infestations of exotic and invasive species throughout the site were mapped (Figure 32). Exotic and invasive species observed in abundance include garlic mustard, autumn olive, ground ivy, Japanese honeysuckle, amur honeysuckle, Morrow's honeysuckle, Nepalese browntop, black locust, Japanese rose (multiflora rose), Siberian elm (*Ulmus pumila*), common privet, and common periwinkle. These infestations are primarily located around the perimeter of the site, adjacent to roads, adjacent to development, in areas that were historically cleared and are beginning to reforest naturally, and in areas prone to natural disturbance such as flooding (along Griffy Creek and its tributary). Exotic species are also present in Griffy Lake, but were not surveyed in this study.

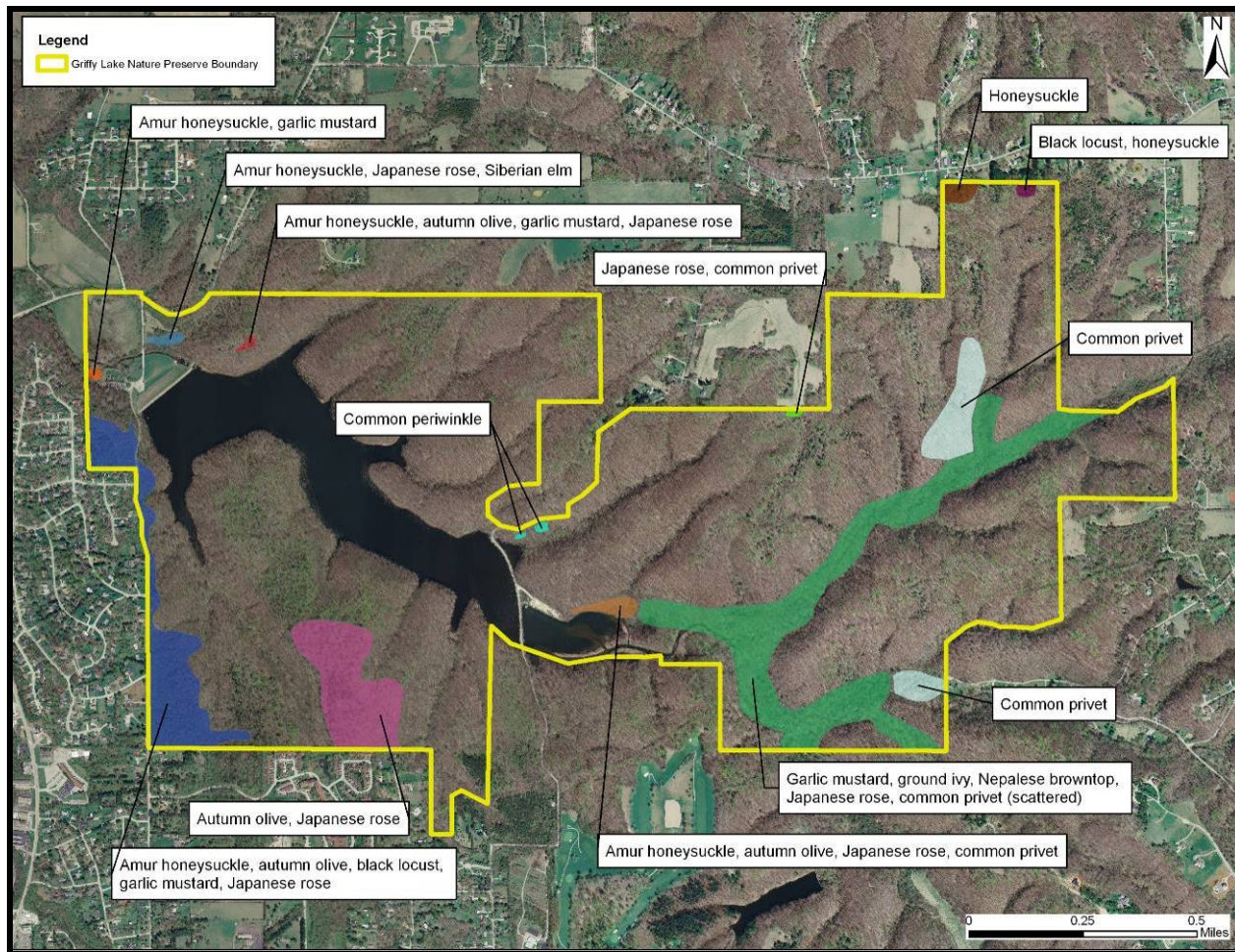


Figure 32. Terrestrial exotic and invasive species mapped within Griffy Lake Nature Preserve, May, June, and September, 2007.

6.1.6 Summary

A total of 564 vascular plant species were identified at Griffy Lake Nature Preserve in 2007, 465 of which are native to Indiana. Twelve additional plants were observed but not identified to species. The site contains a diverse mix of plant species because of elevation differences and the presence of a wide range of soil moisture and chemistry.

Ten ecological communities were mapped on the site, ranging in natural area quality from very low to high. The largest of these is the Mesic Upland Forest, followed by the Dry-Mesic Upland

Forest and Floodplain Forest. Areas of highest natural area quality include the Mesic Upland Forest, Dry-Mesic Upland Forest, and Wet Floodplain Forest, while areas of lowest natural area quality include Developed, Heavily Degraded/Exotics, and Old Field. Other ecological communities observed include Lake, Emergent Marsh, Wet-Mesic Floodplain Forest, Mesic Floodplain Forest, Young (Successional) Mesic Upland Forest, Young (Successional) Dry-Mesic Upland Forest, Red Cedar Barrens, and Historic Conifer Plantation.

Populations of 16 listed plant species, one of which was located just off-site, were observed during the site visits. Three of these species have been introduced at the site in plantations or as escapes from cultivation. Of the other 12 species, three are currently listed as State Rare, and nine are included on the Indiana Watch List.

Twelve exotic and invasive species are present in abundance at the site. Populations of these species are concentrated around the perimeter of the site, adjacent to roads, adjacent to development, in areas that were historically cleared and are beginning to reforest naturally, and in areas prone to natural disturbance such as flooding (along Griffy Creek and its tributary). Exotic species are also present in Griffy Lake.

6.1.7 Recommendations

Several action items are recommended to maintain the diversity and richness of plant species and the high quality of the natural plant communities at Griffy Lake Nature Preserve. Recommendations include controlling exotic and invasive plant species, performing a study on the impacts of deer on the native plant communities, making decisions regarding successional plant communities, preserving areas with large/old trees, and continuing to monitor populations of ETR and Watch List plant species. Additionally, Bloomington Parks and Recreation should continue their involvement with the newly-formed Southern Indiana Cooperative Weed Management Area (SICWMA). The SICWMA is in its foundation stage and hopes to formalize structure, establish funding, and develop operational and programming information during 2008. In the future, SICWMA hopes to offer grants and assistance for partners and area residents to control the spread of exotic species. At a minimum, Bloomington Parks and Recreation should continue to be involved in this effort.

Exotic, Invasive Species Control

Currently, the greatest threat to the biodiversity of the site is the presence and abundance of exotic and invasive species. Figure 33 details the prioritized recommendations for exotic, invasive species control at Griffy Lake Nature Preserve. It is recommended that exotic and invasive species be eradicated where possible, and controlled where complete removal is not possible. Priority should be placed on exotic species populations that immediately threaten imperiled plant species or high quality natural communities. Specifically, populations of large-seeded mercury are located along Griffy Creek and its tributary, areas which are also infested with garlic mustard, ground ivy, Nepalese browntop, Japanese rose (multiflora rose), and common privet. If left untreated, these exotic and invasive species have the potential to create habitat unsuitable for this State Rare species. In areas where major infestations of exotic and invasive species border natural communities, such as Mesic Upland Forest and Dry-Mesic Upland Forest communities, the perimeter of the exotic and invasive species area should be surveyed from year to year, and if these areas are increasing in size, they should be controlled to prevent encroachment into the natural communities. Similarly, minor occurrences of exotic and invasive species that are present within the natural communities should be sought out and removed before they become major infestations. In total, treatment of exotic and invasive species included in this high priority (Priority 1) treatment area cover 97.3 acres. This includes a 30' wide buffer around the perimeter of exotic and invasive species populations that are

adjacent to natural communities, but does not include minor occurrences of exotic and invasive species present within natural communities. The next priority area for removal of exotic and invasive species should be in the Young (Successional) Mesic Upland Forest. Removal of exotic and invasive species will give this community the opportunity to develop into a mature Mesic Upland Forest. Treatment of exotic, invasive species included in this moderate priority (Priority 2) treatment area cover 17.5 acres. Finally, the Heavily Degraded/Exotics community should be treated to reduce and eventually eliminate exotic species; in these areas, it will be necessary to plant and seed native vegetation after controlling the exotic and invasive species. Native species should also be reintroduced in other areas of exotic and invasive species control, if the amount of disturbance caused by the control efforts warrants it. In total, treatment of exotic, invasive species included in this low priority (Priority 3) treatment area cover 32.7 acres.

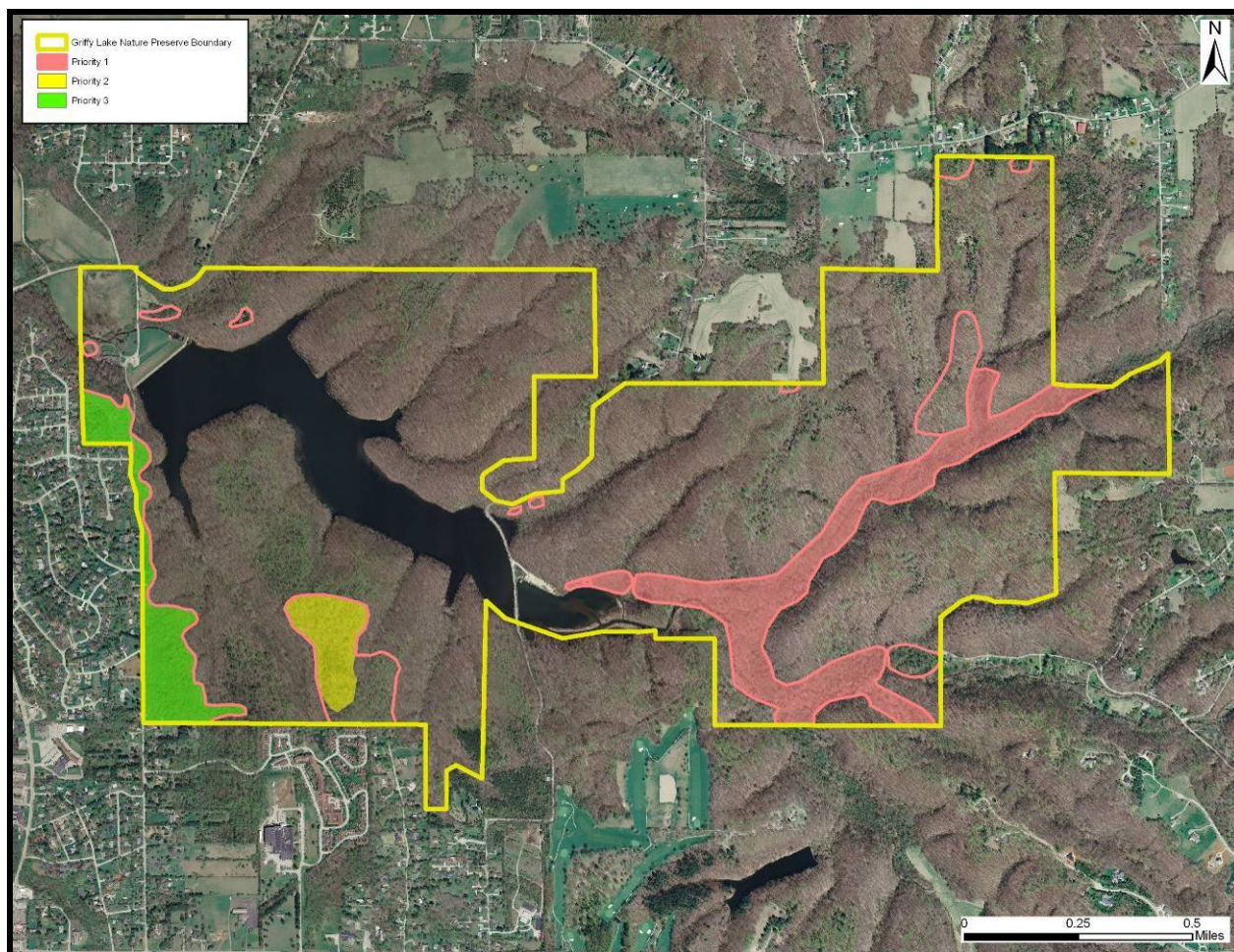


Figure 33. Prioritized recommendations for exotic, invasive species control at Griffy Lake Nature Preserve.

Specific options for controlling each of the exotic species identified on-site are included in Appendix D. Species and/or community specific recommendations for the control of individual exotic species are detailed below.

Woody Species It is recommended that the woody species be controlled during the winter. Control of all species should be concurrent to maximize efficiency. Woody species should be controlled using cut stump methods for smaller individuals and girdling on larger trees. All cut

surfaces should be treated with a 50% glyphosate solution. Crews can typically move at a rate of one-half acre per man hour depending on the density of the species to be controlled and the terrain. This method uses a very minimal amount of herbicide as a minimal amount of actual surface area is actually treated with the herbicide. Aquaneat, a typical glyphosate-based chemical, costs \$31 for one gallon of concentrated chemical. Five gallons of concentrate chemical should be sufficient to treat the woody species identified at Griffy Lake Nature Preserve. Chemical amounts can vary widely based on the density of individuals present; therefore, these costs are estimated based on moderate density and moderate terrain.

Garlic Mustard It is recommended that large populations be controlled using a cold weather application of 2% glyphosate solution. Smaller populations can be controlled by pulling. Hand pulling should be done after the plants have bolted (produced flowers from the stalk). Pulled plants need to be bagged and removed from the site for proper disposal. Winter foliar applications can be done at a rate of 2 acres per man hour. This rate can vary depending on the terrain and the proximity to a staging area where herbicide can be refilled. A 2.5 gallon of aquaneat should be enough to treat the garlic mustard found on site. Hand pulling efforts are slower due to the need to bag and remove pulled plants. Hand pulling can be done at a rate of one-half acre per man hour. Again, this rate can vary depending on the terrain and the density of the populations.

Nepalese Browntop It is recommended that small populations be hand pulled. Industry standards suggest that large populations should be controlled using an aquatic approved glyphosate herbicide, such as aquaneat. However, research completed at IURTP indicates that the use of glyphosate kills not only the Nepalese browntop, but also adjacent native species. Flory (2008) indicates that grass-specific herbicides, such as Fusilade DX, are actually the preferred treatment method. Hand pulling of small populations can be done at a rate of 1 acre per man hour with chemical control of larger populations being done at a rate of 2 acres per man hour. A 2% solution of aquaneat and/or the level recommended on the grass-specific herbicide should be used in control efforts. Chemical amounts depend on the actual size of areas to be treated.

Ground Ivy and Common Periwinkle As these species are relatively non-invasive, their control is not necessary. However, if their control is determined a priority, it is recommended that small populations of these species be hand pulled and that large populations be treated with a broadleaf-specific herbicide, such as Garlon 3A. Another option that Bloomington Parks and Recreation may wish to try for these herbaceous species is an organic pesticide. Two options (d-limonene and acetic acid) are currently available and are targeted at controlling young, herbaceous growth with one application. Marketing materials for both species indicate the highest likelihood of success on vegetation that is immature and actively growing. Hand pulling is another option for these species. Small populations can be pulled fairly quickly if the soil is damp. Populations could be hand pulled at a rate 1 acre per man hour. Chemical control can be accomplished more quickly at a rate of 2 acres per man hour. These rates will vary depending on the terrain and the density of the populations to be controlled.

Deer Population Effects

Effects of recent deer activity were noted during the site inspections. In some parts of the site, particularly in the Mesic Upland Forest and Floodplain Forest, deer browse and trampling along deer paths appeared severe. A study to determine the effects of deer browse at the site is recommended. The study should use deer enclosure plots to determine whether there is an overabundance of deer at the site, and how the plant communities respond when the pressure

of the presumed overabundance of deer is removed. It may be necessary to introduce population controls in the future to reduce the number of deer and their effects on the site.

Prescribed Burning

Depending on the long-term management goals for the property, prescribed burning or selective thinning of trees may be recommended. Windthrow is likely a natural cause of disturbance at the site, especially in areas with shallow soil. With heavy winds, trees are felled, and the resulting canopy gap is colonized by early successional, shade-intolerant species. Fire may also have occurred at the site historically, preventing open oak woodlands on terraces from transitioning into the climax community of beech-maple forests. Griffy Lake Nature Preserve currently exists in various stages of succession, ranging from Old Field to mature Mesic Upland Forest communities. Dry-Mesic Upland Forest is currently present in shallow, dry soils along many upper slopes and terraces throughout the site. Evidence at the site suggests that the portions of the Dry-Mesic Upland Forest that are not located on steep slopes are transitioning into Mesic Upland Forest as organic matter accumulates, soils become deeper and more moist, and climax community native plant species begin to move in. Similarly, the Young (Successional) Dry-Mesic Upland Forest areas that are currently rich with understory vegetation are beginning to transition into Dry-Mesic Upland Forest, as the over story matures and native species typical in this plant community begin to move in. While they are natural, these successional processes will eventually lead to a reduction in overall species richness as these communities progress towards the climax community. Decisions must be made regarding the desired successional stage(s) for the property. If the long-term management goals include maintaining open areas and keeping Dry-Mesic Upland Forest on terraces from transitioning into Mesic Upland Forest, it is recommended that prescribed burning, and potentially selective thinning of native trees, take place within these communities. If the goal is to allow the site to progress naturally into the climax community, then burning is not recommended; it is then recommended that the young forest communities be allowed to naturally transition into more mature forest after exotic species are controlled. Either strategy will affect the continued presence and vigor of individual plant species, including the ETR and Watch List species, in some way; individual species have different responses to burning and the resulting increase in light levels, as well as to the decreasing light levels expected as a community matures.

ETR and Watch List Observations

Although this survey included noting ETR and Watch List plant species when observed, the site visits did not include an exhaustive survey for these species. It is recommended that additional surveys targeting specific ETR and Watch List species take place, and that the populations of ETR and Watch List species be monitored every several years to ensure that the populations are not decreasing. It is also recommended that the areas with ETR and Watch List species present be preserved in their current successional stage. Walking trails should avoid areas with sensitive species, including the steep slopes in the Dry-Mesic Upland Forest. It is also recommended that areas with large, mature trees be preserved. Specifically, areas in which larger trees were noted were located near the southeast corner of the western half of the site, near the middle of the western half of the site north of Griffy Lake, and northeast of the parking lot along Hinkle Road.

6.2 Mammal Community Inventory

The purpose of the present study is to accumulate information on the mammals of Griffy Lake Nature Preserve, and particularly to determine if endangered or threatened species are present.

6.2.1 Introduction

Prior to completing on-site work, an assessment of anticipated species was completed. Based on this bench research, mammal species that might reasonably be expected to occur at Griffy Lake Nature Preserve, as documented in Mumford and Whitaker (1982), are as follows: the Virginia opossum (*Didelphis virginiana*), masked shrew (*Sorex cinereus*), smoky shrew (*Sorex fumeus*), pygmy shrew (*S. hoyi*), southeastern shrew (*S. longirostris*), short-tailed shrew (*Blarina brevicauda*), eastern mole (*Scalopus aquaticus*), big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), little brown myotis (*Myotis lucifugus*), northern myotis (*M. septentrionalis*), Indiana myotis (*M. sodalis*), eastern pipistrelle (*Perimyotis subflavus*), evening bat (*Nycticeius humeralis*), eastern cottontail (*Sylvilagus floridanus*), eastern chipmunk (*Tamias striatus*), woodchuck (*Marmota monax*), gray squirrel (*Sciurus carolinensis*), fox squirrel (*S. niger*), southern flying squirrel (*Glaucomys volans*), American beaver (*Castor canadensis*), common muskrat (*Ondatra zibethicus*), Norway rat (*Rattus norvegicus*), white-footed mouse (*Peromyscus leucopus*), prairie deer mouse (*Peromyscus maniculatus bairdii*), meadow vole (*Microtus pennsylvanicus*), prairie vole (*M. ochrogaster*), woodland vole (*M. pinetorum*), bog lemming (*Synaptomys cooperi*), house mouse (*Mus musculus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), least weasel (*Mustela nivalis*), long-tailed weasel (*M. frenata*), mink (*M. vison*), striped skunk (*Mephitis mephitis*), and white-tailed deer (*Odocoileus virginianus*). No endangered, threatened, or rare (ETR) mammal species are included in the IDNR Natural Heritage Database for the Griffy Lake Nature Preserve. However, the ETR listing for Monroe County indicates that northern river otter (*Lutra canadensis*), bobcat (*Lynx rufus*), least weasel (*Mustela nivalis*), Indiana bat, eastern woodrat (*Neotoma magister*), and American badger (*Taxidea taxus*) were present in Monroe County at some point in the past.

6.2.2 Methods

Small, snap-back mousetraps and pitfall traps (sunken cans) were used to sample the small mammals at Griffy Lake Nature Preserve. An attempt was made to sample the major habitats present. However, since the majority of the property is wooded, a limited number of distinct mammal habitats were present with GLNP. In order to document communities present within each distinct habitat, traps were set near the dry edge of the property where it abutted old field (grassy and/or weedy), within forested areas, and in marshy areas close to the lake. Figure 34 details trap locations. Specifically, traps were set in 33 mousetrap lines, each of which contained 100 traps per line, and in 8 pitfall lines, which contained 10 sunken cans (1000 ml beakers) per line. These traps were sunk to ground level usually under logs and in the runways of small mammals. For comparison, data were summarized as number trapped per 100 trap-nights with one trap for one night counting as a trap-night.

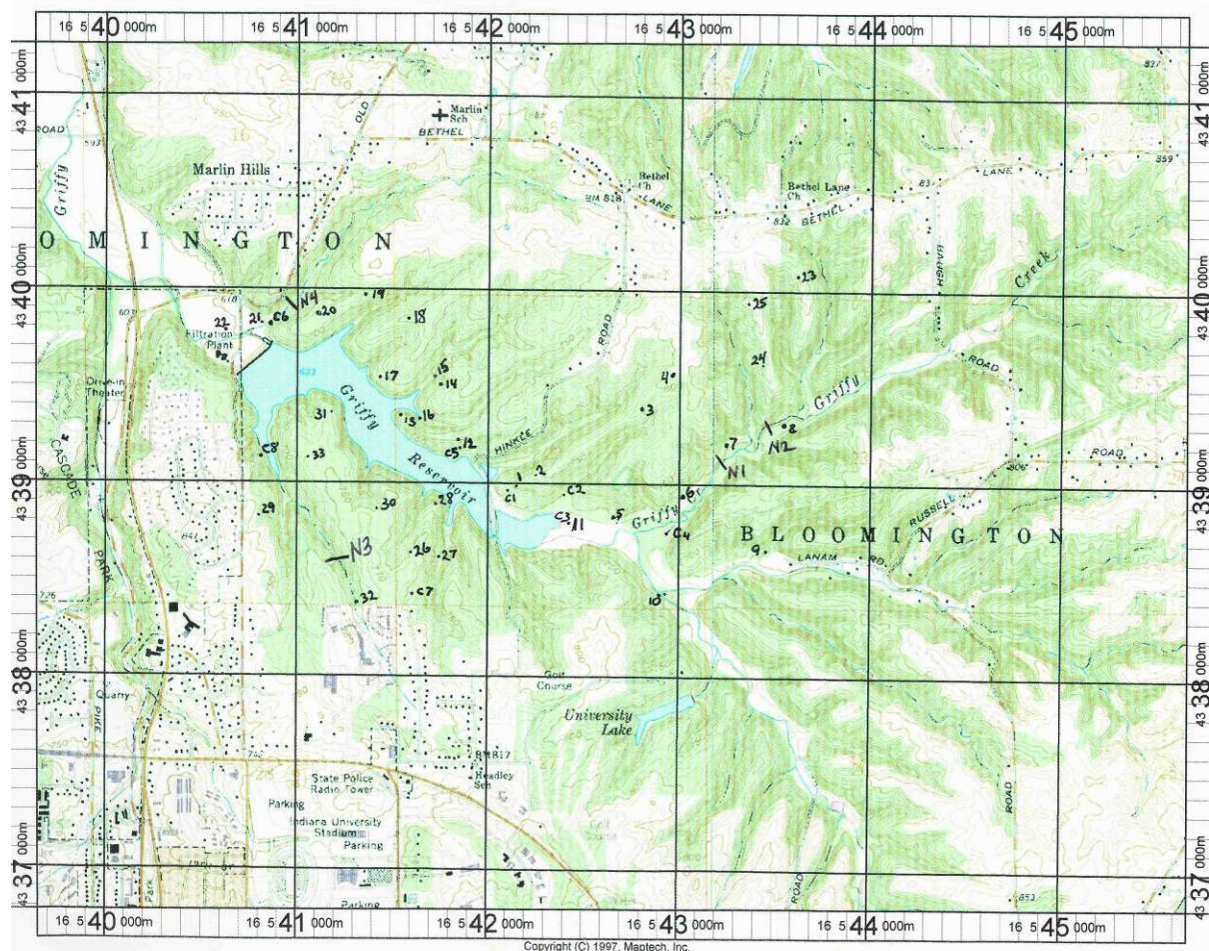


Figure 34. Deployed trap locations used during mammal surveys completed in 2007 at Griffy Lake Nature Preserve. Numbered dots indicate trapping locations, while numbers preceded by a C indicate sunken can lines, and numbers preceded by N indicate a net site.

No attempt was made to trap the larger animals at Griffy Lake Nature Preserve. Rather, documentation of these species was made by observation on site and the presence of tracks, dens, markings, scat, and road kill.

Mist-netting for bats was conducted at four sites on the property. Each site was netted for one night with two nets deployed per site as detailed in Figure 34. Nets were draped across the flyway between the vegetation at each side and extended up to the canopy above. The nets were on a pulley system so that they could be raised and lowered as necessary to retrieve bats. Nets were erected before sunset and in place for 3 hours. Bat detectors were used in addition to the nets to monitor the bat activity in the vicinity of the nets. Data on species, sex, age, reproductive condition, right forearm length, and weight were collected for each captured individual.

6.2.3 Survey Results

A total of 100 small mammals representing seven species were collected in small mammal traps at GLNP between June 14 and 23, 2007 (Table 4). Trapped mammals include 58 white-footed mice, 19 short-tailed shrews, 14 woodland voles, five smoky shrews, two pygmy shrews, one

meadow vole, and one eastern chipmunk. Additionally, three species of bats were documented while mist-netting during this survey including the big brown bat, northern myotis, and eastern pipistrelle. Details of each collection by location are documented in Appendix X.

Table 4. Small mammals trapped at Griffy Lake Nature Preserve, June 14 to July 23, 2007.

Species name	Woods 33 lines; 13,100TN	Pitfalls 8 lines; 1,370TN	Total 41 lines; 14,470 TN
Short-tailed shrew	15	4	19
Smokey shrew	0	5	5
Pygmy shrew	0	2	2
White-footed mouse	57	1	58
Woodland vole	5	9	14
Meadow vole	1	0	1
Eastern chipmunk	1	0	1
Total (Number/100TN)	79 (0.60)	21 (1.53)	100 (0.69)

TN = trap nights

In addition to the animals trapped and netted, several other species were documented on the property by observing them, their tracks, dens, markings, and/or scat. Documented species include: eastern mole, woodchuck, fox squirrel, gray squirrel, flying squirrel, striped skunk, eastern cottontail, white-tailed deer, coyote, red fox, Virginia opossum, and raccoon.

The number of small mammals trapped was relatively low. This is likely due to the area containing relatively uniform habitat with most of the site being forested. Even though there was low species abundance, an interesting assemblage of small mammals was documented. The woodland vole is seldom taken in numbers, but was the third most commonly taken species at GLNP. The species most commonly found in woods in southern Indiana is the white-footed mouse and, not surprisingly, it was the most common species trapped at GLNP. Two species of shrews, the smoky shrew and pygmy shrew, were first taken in Indiana in the un-glaciated hill country (Caldwell et al., 1983) and considered are restricted in Indiana to that area (Cudmore and Whitaker, 1984; Whitaker and Cudmore, 1988). Both species were trapped during this study.

Many of the small mammal species that Mumford and Whitaker (1982) document as potential for this site, such as prairie voles and least shrews (*Cryptotis parva*), are found in grassy fields. This type of habitat is limited within Griffy Lake Nature Preserve; therefore, their absence is not surprising. Also, there were no cultivated fields on the property, which is probably the reason that prairie deer mice or house mice were not collected.

These findings are consistent with other mammal surveys completed at Griffy Lake Nature Preserve. Thiele (1982) documented the presence of white-tail deer, raccoon, striped skunk, opossum, eastern cottontail, gray squirrel, red fox, chipmunk, white-footed mouse, common shrew, woodchuck, and muskrat within Griffy Lake Nature Preserve. Neither study detailed densities of medium and large mammals, such as white-tail deer; therefore, discussions of population changes over time are difficult. However, it should be noted that negative impacts from this component of the mammal community have been documented. Therefore, control of the deer community should be considered as a long-term management option for both the

health of the white-tail deer population and for the continued density and diversity of the flora present within the Griffy Lake Nature Preserve.

6.3 Bird inventory

6.3.1 Introduction

Over the later half of the spring season (2007) through the first part of the winter season (2008), 157 bird species were recorded utilizing the Griffy Lake area. The censuses were completed by visual and auditory identification during informal walks and observations of the area with an emphasis to maximize the different types of habitats (on the lake, lake-side, stream-side, wooded, riparian, secondary growth, and mature forest) and area covered.

6.3.2 Survey Methods

Using the Breeding Bird Atlas protocol (IDNR, 2007), surveyors meandered the Griffy Lake Nature Preserve to document bird species. Once birds were identified by site or call, notation of bird's activity at the time of observation was made, if possible. Surveys were completed throughout the seasons from April 2007 through April 2008. Surveys occurred on April 19 and 20; May 1-3, 5, and 7; June 6, 7, and 21; July 10 and 16; September 12-14, 21, and 29; October 5, 9, and 29; November 9 and 15, 2007; January 16; February 12 and 29; March 5, 23, 31; April 9, 11, 13, 15-18, 23, and 28-29. Historical records for birds previously observed at Griffy Lake Nature Preserve but not observed during the current survey period are also included in the listing.

6.3.3 Survey Results

During the seasonal surveys, surveyors identified 130 bird species and confirmed nesting of 27 species, and have probable designations for five more species. Table 5 details the birds identified at Griffy Lake Nature Preserve during the surveys, while Appendix X documents the dates which birds were observed and any activities in which the birds were engaged during observation. (Bold species in Appendix X detail those for which nesting designations have not yet been confirmed.) Since surveyors did not repeatedly survey the same area during the breeding season, nor did systematic observation of nest occur, these numbers are conservative with respect to the species that are breeding in the area. It is probably safe to assume that species that species found on multiple sites or in the same area throughout the breeding season were breeders.

Table 5. Bird species observed at Griffy Lake Nature Preserve from April 2007 through April 2008 seasonal surveys.

Common Name	Scientific Name
Acadian Flycatcher	<i>Empidonax virescens</i>
Alder Flycatcher	<i>Empidonax alnorum</i>
American Coot	<i>Fulica americana</i>
American Crow	<i>Corvus brachyrhynchos</i>
American Goldfinch	<i>Carduelis tristis</i>
American Kestrel	<i>Flaco sparverius</i>
American Redstart	<i>Setophaga ruticilla</i>
American Robin	<i>Turdus migratorius</i>
American Tree Sparrow	<i>Spizella arbore</i>
American Woodcock	<i>Scolopax minor</i>
Baltimore Oriole	<i>Icterus galbula</i>
Bank Swallow	<i>Riparia riparia</i>

Common Name	Scientific Name
Barn Swallow	<i>Hirundo rustica</i>
Barred Owl	<i>Strix varia</i>
Bay-breasted Warbler	<i>Dendroica castanea</i>
Belted Kingfisher	<i>Ceryle alcyon</i>
Black Tern	<i>Chlidonias niger</i>
Black Vulture	<i>Coragyps atratus</i>
Black-and-white Warbler	<i>Mniotilta varia</i>
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>
Black-crowned Night-heron	<i>Nycticorax nycticorax</i>
Blackpoll Warbler	<i>Dendroica striata</i>
Black-throated Green Warbler	<i>Dendroica virens</i>
Blue Grosbeak	<i>Guiraca caerulea</i>
Blue Jay	<i>Cyanocitta cristata</i>
Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>
Blue-headed Vireo	<i>Vireo solitarius</i>
Blue-winged Teal	<i>Anas discors</i>
Blue-winged Warbler	<i>Vermivora pinus</i>
Broad-winged Hawk	<i>Buteo platypterus</i>
Brown Creeper	<i>Certhia americana</i>
Brown Thrasher	<i>Toxostoma rufum</i>
Brown-headed Cowbird	<i>Molothrus ater</i>
Bufflehead	<i>Bucephala albeola</i>
Canada Goose	<i>Branta canadensis</i>
Cape May Warbler	<i>Dendroica tigrina</i>
Carolina Chickadee	<i>Poecile carolinensis</i>
Carolina Wren	<i>Thryothorus ludovicianus</i>
Caspian Tern	<i>Sterna caspia</i>
Cedar Waxwing	<i>Bombycilla cedrorum</i>
Cerulean Warbler	<i>Dendroica cerulea</i>
Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>
Chimney Swift	<i>Chaetura pelagica</i>
Common Goldeneye	<i>Bucephala clangula</i>
Common Grackle	<i>Quiscalus quiscula</i>
Common Loon	<i>Gavia immer</i>
Common Moorhen	<i>Gallinula chloropus</i>
Common Yellowthroat	<i>Geothlypis trichas</i>
Cooper's Hawk	<i>Accipiter cooperii</i>
Dark-eyed Junco	<i>Junco hyemalis</i>
Downy Woodpecker	<i>Picoides pubescens</i>
Eastern Bluebird	<i>Sialia sialis</i>
Eastern Kingbird	<i>Tyrannus tyrannus</i>
Eastern Phoebe	<i>Sayornis phoebe</i>
Eastern Screech-Owl	<i>Otus asio</i>
Eastern Towhee	<i>Pipilo erythrophthalmus</i>
Eastern Wood-Pewee	<i>Contopus virens</i>
European Starling	<i>Sturnus vulgaris</i>
Field Sparrow	<i>Spizella pusilla</i>

Common Name	Scientific Name
Forster's Tern	<i>Sterna forsteri</i>
Fox Sparrow	<i>Passerella iliaca</i>
Golden-crowned Kinglet	<i>Regulus satrapa</i>
Gray Catbird	<i>Dumetella carolinensis</i>
Gray-cheeked Thrush	<i>Catharus minimus</i>
Great Blue Heron	<i>Ardea herodias</i>
Great Crested Flycatcher	<i>Myiarchus crinitus</i>
Great Egret	<i>Ardea alba</i>
Greater White-fronted Goose	<i>Anser albifrons</i>
Green Heron	<i>Butorides virescens</i>
Hairy Woodpecker	<i>Picoides villosus</i>
Hermit Thrush	<i>Catharus guttatus</i>
Hooded Merganser	<i>Lophodytes cucullatus</i>
Hooded Warbler	<i>Wilsonia citrina</i>
House Finch	<i>Carpodacus mexicanus</i>
House Wren	<i>Troglodytes aedon</i>
Indigo Bunting	<i>Passerina cyanea</i>
Kentucky Warbler	<i>Oporornis formosus</i>
Killdeer	<i>Charadrius vociferus</i>
King Rail	<i>Rallus elegans</i>
Least Flycatcher	<i>Empidonax minimus</i>
Lesser Scaup	<i>Aythya affinis</i>
Lesser Yellowlegs	<i>Tringa flavipes</i>
Little Blue Heron	<i>Egretta caerulea</i>
Louisiana Waterthrush	<i>Seiurus motacilla</i>
Magnolia Warbler	<i>Dendroica magnolia</i>
Mallard	<i>Anas platyrhynchos</i>
Merlin	<i>Falco columbarius</i>
Mourning Dove	<i>Zenaida macroura</i>
Mourning Warbler	<i>Oporornis philadelphia</i>
Nashville Warbler	<i>Vermivora ruficapilla</i>
Northern Bobwhite	<i>Colinus virginianus</i>
Northern Cardinal	<i>Cardinalis cardinalis</i>
Northern Flicker	<i>Colaptes auratus</i>
Northern Mockingbird	<i>Mimus polyglotto</i>
Northern Parula	<i>Parula americana</i>
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>
Northern Saw-whet Owl	<i>Aegolius acadicus</i>
Northern Waterthrush	<i>Seiurus noveboracensis</i>
Orchard Oriole	<i>Icterus spurius</i>
Osprey	<i>Pandion haliaetus</i>
Ovenbird	<i>Seiurus aurocapillus</i>
Palm Warbler	<i>Dendroica palmarum</i>
Philadelphia Vireo	<i>Vireo philadelphicus</i>
Pied-billed Grebe	<i>Podilymbus podiceps</i>
Pileated Woodpecker	<i>Dryocopus pileatus</i>
Prairie Warbler	<i>Dendroica discolor</i>

Common Name	Scientific Name
Prothonotary Warbler	<i>Protonotaria citrea</i>
Purple Finch	<i>Carpodacus purpureus</i>
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>
Red-breasted Nuthatch	<i>Sitta canadensis</i>
Red-eyed Vireo	<i>Vireo olivaceus</i>
Redhead	<i>Aythya Americana</i>
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>
Red-shouldered Hawk	<i>Buteo lineatus</i>
Red-tailed Hawk	<i>Buteo jamaicensis</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>
Ruby-crowned Kinglet	<i>Regulus calendula</i>
Ruby-throated Hummingbird	<i>Archilochus colubris</i>
Ruddy Duck	<i>Oxyura jamaicensis</i>
Rusty Blackbird	<i>Euphagus carolinus</i>
Sandhill Crane	<i>Grus canadensis</i>
Scarlet Tanager	<i>Piranga olivacea</i>
Sharp-shinned Hawk	<i>Accipiter striatus</i>
Solitary Sandpiper	<i>Tringa solitaria</i>
Song Sparrow	<i>Melospiza melodia</i>
Sora	<i>Porzana carolina</i>
Spotted Sandpiper	<i>Actitis macularia</i>
Summer Tanager	<i>Piranga rubra</i>
Swainson's Thrush	<i>Catharus ustulatus</i>
Swamp Sparrow	<i>Melospiza georgiana</i>
Tennessee Warbler	<i>Vermivora peregrina</i>
Tree Swallow	<i>Tachycineta bicolor</i>
Tufted Titmouse	<i>Baeolophus bicolor</i>
Turkey Vulture	<i>Cathartes aura</i>
Veery	<i>Catharus fuscescens</i>
Warbling Vireo	<i>Vireo gilvus</i>
White-breasted Nuthatch	<i>Sitta carolinensis</i>
White-eyed Vireo	<i>Vireo griseus</i>
White-throated Sparrow	<i>Zonotrichia albicollis</i>
Wild Turkey	<i>Meleagris gallapavo</i>
Wilson's Snipe	<i>Gallinago delicata</i>
Wilson's Warbler	<i>Wilsonia pusilla</i>
Winter Wren	<i>Troglodytes troglodytes</i>
Wood Duck	<i>Aix sponsa</i>
Wood Thrush	<i>Hylocichla mustelina</i>
Worm-eating Warbler	<i>Helmitheros vermivorus]</i>
Yellow Warbler	<i>Dendroica petechia</i>
Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>
Yellow-crowned Night-Heron	<i>Nyctanassa violacea</i>
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>

Common Name	Scientific Name
Yellow-rumped Warbler	<i>Dendroica coronata</i>
Yellow-throated Vireo	<i>Vireo flavifrons</i>
Yellow-throated Warbler	<i>Dendroica dominica</i>

6.3.4 Special Conservation Concern List Species

Grippy Lake Nature Preserve is used by many migratory species including the Solitary Sandpiper and many warbler species. Below is a list of species that were identified during the GLNP surveys that are on the National Audubon Society's (2007) and/or the Partners In Flight (2007) Species of Special Conservation Concern lists:

Species of Conservation Concern: Global (showing global population declines)
 Cerulean Warbler (breeder)

Species of Conservation Concern: Continental (showing continental population declines)
 Solitary Sandpiper (migrant)
 Red-headed Woodpecker (breeder)
 Wood Thrush (breeder)
 Blue-winged Warbler (likely breeder in nearby area)
 Prairie Warbler (breeder - in adjacent area)
 Prothonotary Warbler (likely breeder)
 Worm-eating Warbler (breeder)
 Louisiana Waterthrush (breeder)
 Kentucky Warbler (breeder)

Species of Conservation Concern: Regional (showing regional population declines):
 Yellow-billed Cuckoo (likely breeder)
 Chimney Swift (likely nearby breeder)
 Northern Flicker (likely breeder)
 Eastern Wood-Pewee (likely breeder)
 Eastern Kingbird (breeder)
 White-eyed Vireo (likely breeder)
 Blue-gray Gnatcatcher (breeder)
 Eastern Towhee (likely breeder)
 Field Sparrow (likely nearby breeder)
 Orchard Oriole (likely breeder)

Finally, the IDNR Natural Heritage Database does not list any ETR species as occurring at GLNP. However, the Monroe County listing details the following ETR or species of special concern bird species as historically being present in the county. Those species marked with an asterisk (*) indicates that the species was identified at GLNP during the 2007 to 2008 survey period.

Sharp-shinned Hawk*	Red-shouldered Hawk*	Bald Eagle
Bachman's Sparrow	Broad-winged Hawk	Worm-eating Warbler*
Great Egret	Black Vulture	Least Bittern
Great Blue Heron*	Cerulean Warbler*	Black-and-white Warbler*
Upland Sandpiper	Black-throated Green Warbler*	Hooded Warbler*

6.3.5 Canada Goose Populations

The non-migratory population of Canada Goose, which breed at GLNP, is growing, often at the expense and to the detriment of smaller, more sensitive waterfowl species. While data detailing population changes at Griffy Lake Nature Preserve are not available in any form other than anecdotal; this information suggests that a substantial increase in the population has occurred over the past 20 years. The non-migratory population of Canada Geese has expanded exponentially in the eastern United States and is widely considered a nuisance species. Canada Geese are noisy and aggressive and their presence likely will deter other waterfowl (e.g., Wood Duck), and perhaps other land birds from nesting in the area. The grassy shoreline near the boathouse is sometimes overrun with geese (Figure 35). Goose droppings are a problem on the beach area since this is a popular visitor spot. A “Please do not feed the geese” sign is posted at the boat ramp (Figure 36). However, this does not deter geese from the relatively attractive, mowed turf grass area adjacent to the boathouse.

Control of the Canada Goose population by active management via preventing successful reproduction is sanctioned by the IDNR and is recommended for implementation at Griffy Lake Nature Preserve. A simple technique that involves adding the eggs of incubating geese will prevent the eggs from hatching and will encourage the incubating parents to remain with the nest for a long period of time, thereby reducing the likelihood that the pair will re-nest. Additional population control measures may be necessary to reduce the impact of Canada geese on this area of Griffy Lake Nature Preserve. The IDNR can assist with developing a control plan and should be consulted before any control measures are instituted. Additionally, stabilization and/or revegetation of the shoreline adjacent to the boat ramp is recommended. (See the **Shoreline Erosion Section**.) At a minimum, a native plant buffer should be installed in this area to reduce runoff from the parking lot and to deter geese from accessing the shoreline in this location.



Figure 35. Lakeshore/ beach area. Figure 36. Signage at boathouse parking lot.

6.3.6 Recommendations

The Cerulean Warbler is the most significant breeding species in the Griffy Lake Nature Preserve as it is designated as a species of global conservation concern by National Audubon Society and by Partners In Flight. This species appears to be concentrated along Griffy Creek to the east of the lake. With respect to the perpetuation of this species in the area, it is critical to avoid significant disturbance to this riparian area.

The trail system is quite extensive and heavily utilized at Griffy Lake Nature Preserve. At this point in time, the bird population appears to be unaffected by human interaction; therefore, there is no need to restrict movement of hikers in the area. The area is extensive enough and maintained in such a way that the species utilizing the area appear to show little disturbance by

human activity. Additionally, the presence of many species of conservation concern bodes well for the current management practices at Griffy Lake Nature Preserve. Increases in human activities could alter this situation; therefore, recommendations targeting the bird population within Griffy Lake Nature Preserve should be revisited should visitor levels substantially increase within GLNP.

Additionally, off-leash dogs can impact ground nesting bird species and destroy understory habitat. Wood Thrushes, Worm-eating and Kentucky Warblers, and Eastern Towhees are all ground-nesting species of special concern. These populations could be negatively affected by free-ranging dogs. At a minimum, education of GLNP users regarding the problems associated with off-leash dogs and ground nesting bird species should be initiated. Additionally, signage detailing the benefits to wildlife which result from keeping dogs on leash should be posted.

6.4 Amphibian and Reptile Inventory

6.4.1 Introduction

Amphibians and reptiles play key ecological roles in present-day ecosystems as well as important roles in the evolutionary history of animals on Earth. About 360 million years ago, the first amphibian-like animals moved out of water and spent part of their lives on land. This was a key step, because all vertebrate animals (animals with a backbone) on land today descend from this bold ancestor. Today, many amphibians and reptiles fill vital ecological roles in the interface between water and land, though others have left water altogether. The primary role these animals typically fill today lies in the center of the food web, where they can keep animal populations below them in check while serving as conduits of energy to animals above them.

Amphibians and reptiles (hereafter referred to as herps) are cold-blooded, which means that they do not expend biochemical energy to generate body heat. Herps collect their heat from their environment including sunlight, warm rocks, pavement, and other resources. (Amphibians do not do much basking.) Because of this rather large energy savings, herps can be present in surprisingly large numbers. However, they achieve high densities only when other environmental factors are conducive to them. This report focuses on the status of herps at Griffy Lake Nature Preserve, highlighting both the presence of species and insight into their habits or population status. Additionally, this assessment of the property documents the presence of any Endangered, Threatened, or Rare species at GLNP. The INDR Natural Heritage Database does not identify any ETR herps at GLNP. However, two amphibians, including four-toed salamander (*Hemidactylium scutatum*) and northern crawfish frog (*Rana areolate circulosa*), and four reptiles, such as Kirtland's snake (*Clonophis kirtlandii*), timber rattlesnake (*Crotalus horridus*), rough green snake (*Opheodrys aestivus*), and western ribbon snake (*Thamnophis proximus*), are included on the ETR listing for Monroe County.

6.4.2 Survey Methodology

Amphibian and reptile survey methods fall into five categories: visual searches, drift fence traps, turtle traps, aquatic dip net samples, and minnow traps. Visual searches strive to cover as much ground as possible in search of individuals. For terrestrial herps, surveyors walk through areas likely to have these animals, such as sunnier patches in woods or along the north shore of Griffy Lake, but even shadier areas are included. Visual searches also include scans of basking areas, turning over logs and rocks, and removal and replacement of bark.

Drift fence traps consist of a portable fence measuring approximately 50 feet long and 3.5 feet tall anchored by poles at each end with a chain sewn into the bottom (heavy chain presses the base of fence to contours of the ground). At each end, two funnel traps (with a wet sponge in

each) catch animals that encounter the fence and walk along it. Traps are checked each morning and any animals are released unharmed; the fence is moved as needed.

Turtle traps consist of a 50 foot seine tied to two turtle hoop traps, one at each end. A punctured can of tuna is placed in each trap. Turtles cruising the area run into the seine and swim/prowl along it. Once they get a whiff of rotting tuna they continue on into the trap. Traps are checked each morning and any turtles are released unharmed. Traps are placed at various areas around the lake.

Dip net samples are made with a dip net (opening about 50cm X 20cm) in still water areas. Amphibian larvae and adults are the target.

Minnow traps are wire mesh, double funnel traps. These traps are deployed in leafy areas of Grippy Lake during the spring. The intended targets are newts and mudpuppies that may reside in Grippy Lake.

Survey work was conducted on the following days: May 18-21 and 25-27, 2007; July 7-10, 2007; September 9 and 10, 2007; March 11 March, 2008; April 20-21, 2008; May 5, 6, and 22-27, 2008; and June 1 June, 2008.

6.4.3 Amphibian Community

Frogs and Toads

All frogs and toads in Indiana lay eggs in water. (This is not true of all tropical species.) To serve as breeding habitat, aquatic habitats are almost exclusively still waters. This usually means acceptable breeding habitat is in wetlands or lakes; however, still water areas of streams and creeks are sometimes used. Most frogs and toads must use aquatic sites without fish. However, if there is enough submerged cover (e.g. leaf litter, vegetation) some frog and toad species can use aquatic sites with fish as their tadpoles can successfully evade fish predators. Additionally, other species can avoid predation to fish because they possess skin toxins or extremely cryptic coloration and behavior. For the frogs and toads that require fishless waters, this usually means wetlands are their ideal breeding habitat. For some species that breed in late winter/early spring, their tadpoles metamorphose by early or mid-summer; thus, these species can breed in wetlands that sometimes or always dry up. Other species require more reliable water.

Upon metamorphosis, juvenile frogs and toads of all Indiana species disperse onto land to some degree. For many species, movements up to 1 km are not uncommon. Frog juveniles seek areas that have access to moisture, which might be a small, remote body of water (e.g. intermittent creeks) or an area with thick leaf litter and somewhat moist soil. Toad juveniles have thicker skin and can handle somewhat drier conditions, although big-bodied adults are better yet. Anytime it rains, frog and toad juveniles and adults may move. Such movements are primarily to find locations that supply better food, cover, or moisture. However, during mating season, movements tend to be en masse and are directed toward breeding sites.

Grippy Lake Nature Preserve primarily features the lake and backwater "sloughs" as breeding sites. There are a few floodplain pools in the eastern part of the property. Few species breed in Grippy Lake and adjacent fringe wetlands. One floodplain pool connects to the lake, but only very small fish enter the wetland, therefore, some amphibians normally intolerant of breeding with fish, can breed with them. Other floodplain pools are isolated from entry of fish. One very interesting floodplain wetland is below the Grippy Lake dam and across Dunn Street. This sedge/cattail marsh appears to be a natural wetland; however, beaver have built a dam near

where the wetland connects to the creek. This raises water level and enlarges surface area. The dam appears fairly recent, which means now the site should hold water longer into summer and as such should allow for more herps to use the site.

But not all wetland-breeding amphibians living in terrestrial refuges in GLNP will breed on the property. There likely are wetlands (including bull-dozer ponds, some without fish) in the vicinity of GLNP. Juvenile and adult frogs and toads from those wetlands can disperse widely, as noted above. Thus, GLNP can contribute terrestrial habitat to frog and toad (and salamander) populations that actually breed off-site.

GLNP offers prime terrestrial habitat. Many frog and toad species prefer shady conditions for the obvious reason that shade reduces water stress on terrestrial individuals, while leaf litter and logs provide refuges that are safe and moist. Some species of frogs and toads prefer and can tolerate sunnier conditions. These species can find sunny, protected spots in some bayheads, tree blowdown areas, and on some south-facing slopes. One problem for these species is that the dense forest acts somewhat as a barrier to dispersal. Suppose a breeding population of southern leopard frogs were to go extinct in the bayheads on the north side of Griffy Lake. Because of the dense forest around those breeding areas, it may take a while for the species to recolonize the site. Overall, most species find the shady GLNP conditions favorable.

Salamanders and Newts

Salamanders and newts (hereafter salamanders) fall into two neat groups: species that breed in water and species that do not. Representatives of each group live in GLNP.

Salamander species that breed in water can be subcategorized: species that breed in still water and species that breed in gently flowing water (e.g. rocky streams with pools and riffles). For the former, GLNP has floodplain pools, but sampling shows salamanders are very sparse. The main site with salamanders is the sedge/swamp attached to the east of Griffy Lake. Salamander larvae both are preyed on by fish and compete with fish for food. That explains why salamanders are so sparse. It may be that most individuals of still water breeding species are dispersers from off-site breeding populations. (Newt and mudpuppy exceptions are discussed below.) For the latter, the primary aquatic breeding salamanders are two species that breed in fishless streams that sometimes dry up completely or dry to isolated pools. The larvae of these two species prefer fishless sites, but can coexist with small fish.

The small streams and deeply wooded stream valleys at GLNP provide ideal habitats for these two species of salamanders. As long as no pollutants enter the streams and the rocky streambeds are left intact, the streams should continue to provide adequate or even exceptional habitat. As long as the woods persist, the terrestrial habitat should also be exemplary for salamander populations.

Red-spotted newts are a special case. Newts prefer small, sunny ponds that hold water most years. However, they are sometimes found in lakes with fish, sometimes even fairly large lakes. In such cases, red-spotted newts are difficult to find. Another species, the mudpuppy, might also be found in the lake, but is also difficult to find. Anglers are a good source of information on this, as mudpuppies are sometimes caught on hook and line. Sixteen minnow traps were placed over two nights in a leafy bayhead that seemingly might contain newts and/or mudpuppies, but none were caught. If present, they likely are at low density.

Some salamander species do not breed in water. Rather, their eggs are laid in moist enclaves such as burrows by small mammals, in thick piles of leaves, under rocks, or in damp logs.

These species tend to be fairly abundant and are relatively easy to detect in spring by turning over logs. As long as the forest is kept more or less intact and logs allowed to decompose naturally, these species will continue to be present at Griffy Lake Nature Preserve.

6.4.4 Reptile Community

Turtles

Most turtles use Griffy Lake, which should harbor a fair number of species. However, only two species are common; the rest are relatively sparse. Turtle trapping and observations readily detect the common species.

As long as the lake does not undergo radical changes, turtles should continue to occur within GLNP. However, turtles breed on land, which can pose natural and unnatural threats to their population. Turtles generally prefer partly sunny or sunny spots on land for digging their nests. These often are along road embankments, which provide a clear danger to the population. However, they usually move at night, which should reduce vehicle contact somewhat. Raccoons are abnormally abundant along roadsides, so they encounter turtles themselves or their nests at unnaturally high rates, both of which often result in high levels of predation.

Turtles are cold-blooded and like to bask in order to elevate their body temperature. This is especially true in spring, but not restricted to that time of year. Elevated body temperature allows turtles to improve digestion of meals, avoid predators (can move more quickly when warm), and improve mating options. Trees that fall into any part of Griffy Lake should be left, for turtles will clamber onto them for basking.

Sunny spots away from roads, but within GLNP, are uncommon. Because of the thin soils throughout much of the property, tree falls are not uncommon. Recent treefalls can be good areas to dig nests somewhat away from raccoons. As these areas experience blow downs, no attempt should be made to clean up the area or hasten tree re-growth. These openings are good for turtle nesting areas and provide habitat for other reptiles as described below.

Box turtles do not use Griffy Lake, although sometimes during drought they will burrow in the mud on the fringe of the lake or will be found in streams feeding the lake. Otherwise, box turtles use nesting areas similar to those of other aquatic turtles. Box turtles spend most of their time scavenging for food, which brings them into frequent encounters with roads and people. Box turtles are often collected to be kept as pets. Visitors to GLNP should be encouraged to admire but not touch box turtles, as even picking one up can frighten the turtle into expelling its water reserve, which can be a lethal event during drought.

Snakes

Snakes generally are terrestrial for all phases of their life cycle. Water snakes spend some time foraging in water, so they form the main exception. Like turtles, snakes often lay eggs in areas with some sunlight, which helps speed development of young in the eggs. Sites for egg deposition include underneath flat rocks, in rotting logs, in natural crevices, or under human-generated debris, such as lumber or sheet metal. Therefore, naturally created forest openings should be allowed to revegetate at their own pace.

Juvenile and adult snakes like to be warm, which means finding sun. However, most of GLNP is covered by dense forest canopy, where most snake species should be sparse and hard to detect. Higher snake density should be expected in recent blowdown areas. However, drift fence trapping in such an opening on the north side of Griffy Lake yielded no captures over 8 nights of sampling. Snakes also like edges of woodlands and grassy fields; however 6 nights of

drift fence did not capture any snakes in such an ecotone on the north side of GLNP. Not unexpectedly, two nights of drift fence in dense forest yielded no snakes. I have considerable experience and success in using drift fences to capture snakes, so lack of captures strongly suggests snake density at GLNP is generally low.

Tens of hours were spent walking the site, searching every opening or other sunny location, lifting and searching logs and rocks for snakes. These efforts produced some snakes, but the encounter rate was very low from my experience, again emphasizing the general low density of snakes at GLNP.

Sunny areas suitable for snakes are found along Griffy Lake and along roads. However, these locations present danger for snakes; they are easily run over or encountered by human foot traffic. Because of a fear or hatred of snakes by many humans, encounters with humans often result in dead snakes. Pets, feral cats, and dogs also pose dangers to the snake population either. In addition, grassy areas along the dam are periodically mowed which can increase snake mortality.

GLNP does not at present feature optimal snake habitat. Much of it is too shady for most species, thereby funneling them into sunny areas along roads, the lakeshore, and the dam. None of these areas are friendly to snakes.

Lizards

In most ecological senses, lizards are very similar to snakes. They are completely terrestrial. They lay eggs in similar microhabitats (under rocks, in rotting logs, in natural crevices, or under human-generated debris such as lumber or sheet metal). Most species prefer openings in the woods or other sunny areas. In openings, they sometimes can be seen running along downed trees where sunlight is plentiful. Lizards are common along the sunny, south-facing shore of Griffy Lake and in areas of rip-rap.

As described earlier, any natural tree mortality is beneficial for lizards. Openings provide lizards with habitat areas in open sunlight, but also logs on which to travel and in which to breed or hide. That does not mean more shady areas are useless, but they are of lower habitat quality.

6.4.5 Summary of Findings

Below is a summary of species found at GLNP. By each species is a comment on its ecology. Species name and background information follow S.A. Minton. 2001. *Amphibians & Reptiles of Indiana*. Indiana Academy of Science, Indianapolis.

Frogs and Toads

- Cricket frog (*Acris crepitans blanchardi*) breeds in bayheads of Griffy Lake. This species has become very rare north of an east-west line through Indianapolis, but remains common to the south. Cricket frogs are prevalent at GLNP.
- American toad (*Bufo americanus*) breeds in Griffy Lake, especially the shallowest parts of the east end, and are also found in floodplain pools.
- Fowler's toad (*Bufo fowleri*) and some hybrids breed in the shallowest part of Griffy Lake near the east end and in the floodplain pools.
- Cope's gray treefrog (*Hyla chrysoscelis*) probably breeds in off-site ponds, but can breed in lakes with sufficient cover (e.g. leafy, weedy bottom). This species was not identified at GLNP.
- Bullfrog (*Rana catesbeiana*) probably breeds in Griffy Lake where tadpoles not readily eaten by fish.

- Green frog (*Rana clamitans melanota*) could breed in vegetated/leafy backwaters of Griffy Lake and were observed during these surveys.
- Wood frogs (*Rana sylvatica*) breed in floodplain sedge/swamp connected to Griffy Lake and in fishless floodplain pools. It is rare for wood frogs to breed in waters with fish, but in the sedge/swamp west of Dunn Street fish are very small. Wood frogs also breed in off-site ponds.
- Southern leopard frog (*Rana utricularia*) is present and probably breeds in dense, leafy bayheads, especially if grassy areas nearby.
- Spring peeper (*Pseudacris crucifer crucifer*) breeds in dense vegetation areas adjacent to Griffy Lake and in floodplain pools east of the lake.

Salamanders

- Two-lined salamander (*Eurycea cirrigera*) breeds in the clean, rocky, ravines feeding Griffy Lake.
- Longtail salamander (*Eurycea longicauda longicauda*) are found in similar locations as the two-line salamander.
- Four-toed salamander (*Hemidactylium scutatum*) were not identified during the current survey, but were previously identified on-site. Dr. Clara Cotton of IUB reports finding this species in the area east of Griffy Lake. Typically they require mossy tussocks in shallow wetlands, so as long as these wetlands are not adversely affected, this species should be fine. This species is listed by Indiana DNR as "State Endangered".
- Northern slimy salamander (*Plethodon glutinosus*) does not breed in water, but is found on Griffy Lake Nature Preserve.
- Redback salamander (*Plethodon cinereus*) also does not breed in water. This species is very common in and under moist logs in spring. It is found in two forms at GLNP, some with a red stripe down the back and some with no stripe.
- Zigzag salamander (*Plethodon dorsalis dorsalis*) does not breed in water and is very common in and under moist logs and rocks. It looks like redback salamanders, but its reddish orange dorsal stripe is wavy (sometimes lacking stripe as well).
- Jefferson's salamander (*Ambystoma jeffersonianum*) were identified on-site in the form of one egg mass found in the sedge/swamp connected to Griffy Lake. Both competing with and being preyed on by fish prevents Jefferson's salamander from being very abundant. However, if better fishless ponds are near GLNP, then some terrestrial dispersers onto GLNP may increase their population size.
- Marbled salamander (*Ambystoma opacum*) were found in low densities at Griffy Lake Nature Preserve.

Turtles

- Eastern spiny softshell (*Apalone spinifera spinifera*) were identified at GLNP in areas away from raccoon predation.
- Common snapping turtle (*Chelydra serpentina serpentina*) can tolerate almost any water quality. Snappers eat almost any kind of animal, but big individuals often eat plant material (e.g. duckweed). Snapping turtles were identified in Griffy Lake during the survey.
- Midland painted turtle (*Chrysemys picta marginata*) can tolerate almost any water quality and were present at GLNP.
- Common musk turtle (*Sternotherus odoratus*) can be common, but not readily detected as they spend a lot of time in hiding.
- Eastern box turtle (*Terrapene carolina carolina*) are readily detected and probably common at GLNP. Individuals disperse widely and should not be picked up. This species is listed by Indiana DNR as a "Species of Special Concern". This is primarily due to the frequency

with which people collect them as pets. They are common at GLNP, although some are regularly killed on the road leading to the boathouse.

- Red-eared slider (*Trachemys scripta elegans*) were present but are probably not very numerous in Griffy Lake.

Snakes

- Northern copperhead (*Agkistrodon contortrix mokasen*) snakes like dry hillsides, which at GLNP includes some hiking trails, thus encounters with hikers is possible. A bite should not result in panic, just a drive to Bloomington Hospital with an advance phone call.
- Northern ringneck snake (*Diadophis punctatus edwardsi*) is common at GLNP and are often found in sunny openings in the woods. However, it is usually hiding in or under logs.
- Black rat snake (*Elaphe obsoleta obsoleta*) are present at GLNP.
- Midland banded water snake (*Nerodia sipedon pleuralis*; taxonomy of this species sometimes changes) is fairly common along rocky shores of Griffy Lake. When cornered it strikes fiercely and is, as a result, needlessly killed.
- Rough green snake (*Opheodrys aestivus*) is usually found in sunny blowdown areas clinging to branches of small trees. This species is listed by Indiana DNR as a "Species of Special Concern", which means that some decline has been noted, so remaining populations should be monitored. Since GLNP has a fair number of recent blowdowns and many old trees to fall regularly, habitat in the short term at least should be good for this snake.
- Eastern garter snake (*Thamnophis sirtalis sirtalis*) is likely to be found in much of GLNP.

Lizards

- Five-lined skink (*Eumeces fasciatus*) are often found darting along logs on the slopes by Griffy Lake, but also can be found in somewhat shady areas.
- Northern fence lizard (*Sceloporus undulatus hyacinthinus*) are also common on logs on slopes by Griffy Lake, this species is doing very well in its favorite sunny spots.

6.4.5 Recommendations

Blowdowns

Snakes, lizards, and turtles all require sunny areas, so allow for windblown trees to remain down in place and become open habitat areas for sun-loving reptile and amphibians away from roadsides and trails.

Dry-mesic woodland

GLNP is like much of south-central Indiana in that it historically was a mosaic of woodland types. In floodplains a mixed woodland tolerant of short-lived flood was present. In moist soil areas (low slopes grading to floodplain), dense beech-maple forest primarily existed as a climax forest. Extensive disturbance was infrequent as low position tempered high winds and moister soils reduced frequency and intensity of fire. From there, this forest could at times spread to mesic slopes, especially when disturbances (e.g. wind, fire) were reduced. Drier, more exposed (e.g. south or southwest facing slopes) probably faced more frequent intense wind and fire. Historically, this meant that dense shade of beech-maple forest was rare on these sites. However, decades of fire suppression have allowed beech and maple (among others) to invade some relatively dry sites. Periodic fire here would have kept the low and mid height vegetation sparse, thereby allowing significant sun to the woodland floor. This would have benefited snakes, lizards, and turtles such that they did not have to rely solely on blowdown areas to get sufficient sunlight.

Periodic prescribed fire on dry or dry-mesic sites (e.g. south or southwest facing slopes, hilltops) would improve overall habitat for herps that require partial or full sun. Such prescribed fire should be done at a time of year when herps are not active, as they may have trouble escaping flames. (During presettlement times, when natural landscape was everywhere, occasional herp losses to fire were easily offset by improved habitat. In today's more fragmented world, prescribed fire losses should be reduced.) Dry periods in late winter or very early spring (e.g. mid-February to mid-March) should generally be acceptable for herps, as would be most burn times in November.

Nonnative species

Nonnative plant species can proliferate and cause excessive shade in the understory, which is clearly adverse to sun-requiring herps. Removal of these species should be done using best available management practices. In some areas, (e.g. bottomland at east end of Griffy Lake and upstream) significant problems with multiflora rose exist, and garlic mustard is poised to explode. (Garlic mustard is also poised for dastardly duty in the wooded areas below the dam.) In other areas, impenetrable masses of nonnative shrubs (e.g. the southwest sector of GLNP) are ruining habitat by casting excessive shade and fostering no or little leaf litter.

Sedge Marsh below Griffy dam

The sedge marsh below Griffy dam and across Dunn Street appears to be enhanced by recent beaver activity. Overall, this area offers good habitat for reptiles and amphibians. No action should be taken to interfere with beaver activity in this area.

6.5 Soil Erosion Survey

The soil erosion survey consisted of a field investigation to document erosion areas throughout the property and a shoreline erosion survey to document shoreline erosion along the shore of Griffy Lake. The property-wide and shoreline erosion field investigations were conducted during several site visits throughout the 2007 growing season. As previously detailed, soils throughout the Griffy Lake Nature Preserve are considered highly erodible (Figure 6). As such, these soils easily erode due to wind and water often resulting in head-cut formation within stream channels and erosion along steeply-sloped areas. Additionally, many of the steepest slopes within the GLNP are found along Griffy Lake's shoreline (Figure 4). This survey effort attempted to catalog all erosion sites; however, due to the steep nature and thin soils on the property, additional erosion areas may have appeared since the initial survey was completed. The same techniques suggested here can likely be used at any other eroding areas as well.

6.5.1 Methodology

The erosion survey was completed during the initial natural resources inventory survey which occurred May 1 through 3, 2007. Follow-up surveys of specific erosion areas occurred on September 4, 2007. A survey of shoreline erosion areas occurred October 5, 2007. All areas classified as eroding were recorded using a GPS and with photographs.

6.5.2 Streambed and Bank Erosion

Much of the soil erosion occurring within the Griffy Lake Nature Preserve is associated with streambed and bank erosion along Griffy Creek (Figure 37). In some cases, the cause of the identified erosion is likely associated with natural erosion processes, such as water moving over the thin soils on the property. However, many of the erosion areas along Griffy Creek, its tributaries, and other streams within the Griffy Lake Nature Preserve are likely exacerbated by increased runoff. This runoff is likely associated with land use changes throughout each stream's drainage, or watershed. As more water flows into the stream, the erosion rate increases as the drainages incise or down cut within their banks to create additional floodplain storage space.

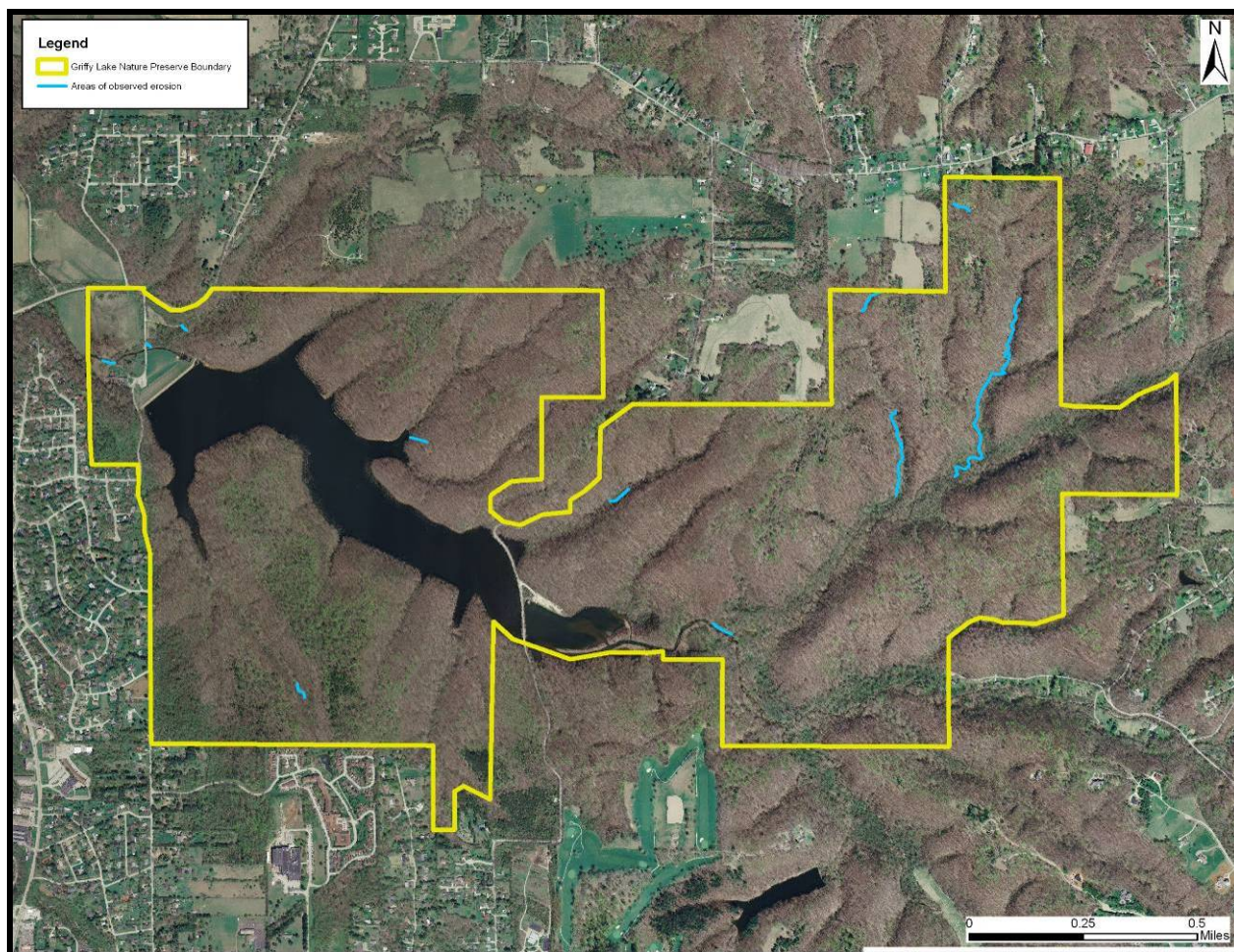


Figure 37. Streambed and bank erosion areas identified throughout Griffy Lake Nature Preserve, May and September 2007.

The conversion of natural landscapes to residential and commercial land uses results in the removal of vegetation and, in the case of urban land, the creation of more impermeable surfaces (Basnyat et al., 2000). These impermeable surfaces coupled with the lack of vegetation to intercept precipitation and runoff results in a decline in the volume of water infiltrating the soil (Corbett et al., 1997). The lack of infiltration causes stormwater, which normally would move through the soil as groundwater or subsurface flow, to move as overland or surface flow. Eventually, overland flow enters the stream channel. Ultimately, the increase in impervious surfaces, lack of emergent vegetation, and absence of stormwater infiltration results in more surface water reaching the stream at a faster rate, thereby creating a flashy stream system characterized by greater variability in water level fluctuations (Tourbier, 1994).

Flashy streams, like many of the small drainages located within GLNP, are often subjected to greater peak flows as a result of the volume and velocity of surface runoff (Ferguson and Deak, 1994). Rapidly fluctuating water levels and high flow volumes increase the erosive force of the water resulting in streambank and bed erosion. As water erodes material at the toe of the slope, the streambanks become unstable. This results in the sloughing of bank material. This material is then carried downstream and deposited in areas of lower velocity. The erosion and deposition

of instream material continues until sediments and sediment-attached nutrients eventually reach Griffy Lake.

The processes of erosion and deposition of bank material continues until the stream reaches a stable condition. In the case of the drainages to Griffy Lake, the relatively steep gradient, thin, erodible soils, and steep streambanks limit the ability of the stream to create stable conditions. Nearly continuous lateral channel migration, bed scour, and bank sloughing results from the unstable conditions present within the streams. Additionally, as more water flows into the stream, the erosion rate increases as the drainages incise or down cut within their banks to create additional floodplain storage space.

Several critical erosion areas were identified during field inventories of Griffy Lake Nature Preserve. Photographs of some representative areas are included in Figures 38 to 41X. The most critical areas of bed and bank erosion occur along Griffy Creek; however, bed and bank erosion also occurs in isolated locations along stream channels throughout the property. Multiple options to reduce streambed and bank erosion and to control the transport of sediment and sediment-attached nutrients to Griffy Lake were identified. Possible solutions include surface water interceptors, such as rain gardens or wetlands, installed in the headwaters of each drainage; water storage on-site in step pools in narrow ravines; streambank stabilization using armoring in the form of wood or rock; or rock check dam installation to reduce the grade and increase flooding frequency within isolated areas of GLNP.



Figures 38 to 41. Streambank erosion occurring within tributaries to Grippy Lake on the Grippy Lake Nature Preserver, May and September, 2007.

6.5.3 Shoreline Erosion

Approximately 610 feet of Grippy Lake's shoreline rated as severely eroding, while an additional 4,350 feet of shoreline rated as moderately eroded (Figure 42). Slight shoreline erosion occurs along approximately 8,050 feet of Grippy Lake's shoreline, while the remaining 8,380 feet rate as not eroding. Severely eroding shoreline represent those areas where erosion occurs along a length of 50 feet or more and extends five or more feet along the face of the slope. Moderately eroding shoreline represents those locations where erosion occurs along 20 feet or more of the shoreline and extends more than two feet along the face of the slope.

Areas rated as severely eroding are typically in this condition due to a combination of natural and anthropogenic forces. Figures 43 through 44 document severely eroding shoreline. As shown in Figure X, the area adjacent to the dog exercise area is one of the highest use areas along the shoreline. This combination of thin soils and excessive foot traffic limits the ability of shoreline vegetation to grow in this area (Figure 45). Without vegetation, the thin soils are exposed to further erosion. These soils stay in suspension and are then transported throughout the lake (Figure 46). In these areas, access to the lake needs to be restricted to allow stabilization and vegetation regrowth to occur. A combination of fencing, brush piles, and down trees should be used to restrict human and pet access to the shoreline. A boardwalk or final gravel path could also be used in these areas to demarcate the trail and limit off-trail use. Additionally, a variety of stabilization techniques are options for stabilization. These include: riprap installation, rock toe shelf creation, and brush mattress and live stake installation. Stabilization of these areas is likely to be the most expensive due to the severity of the erosion.

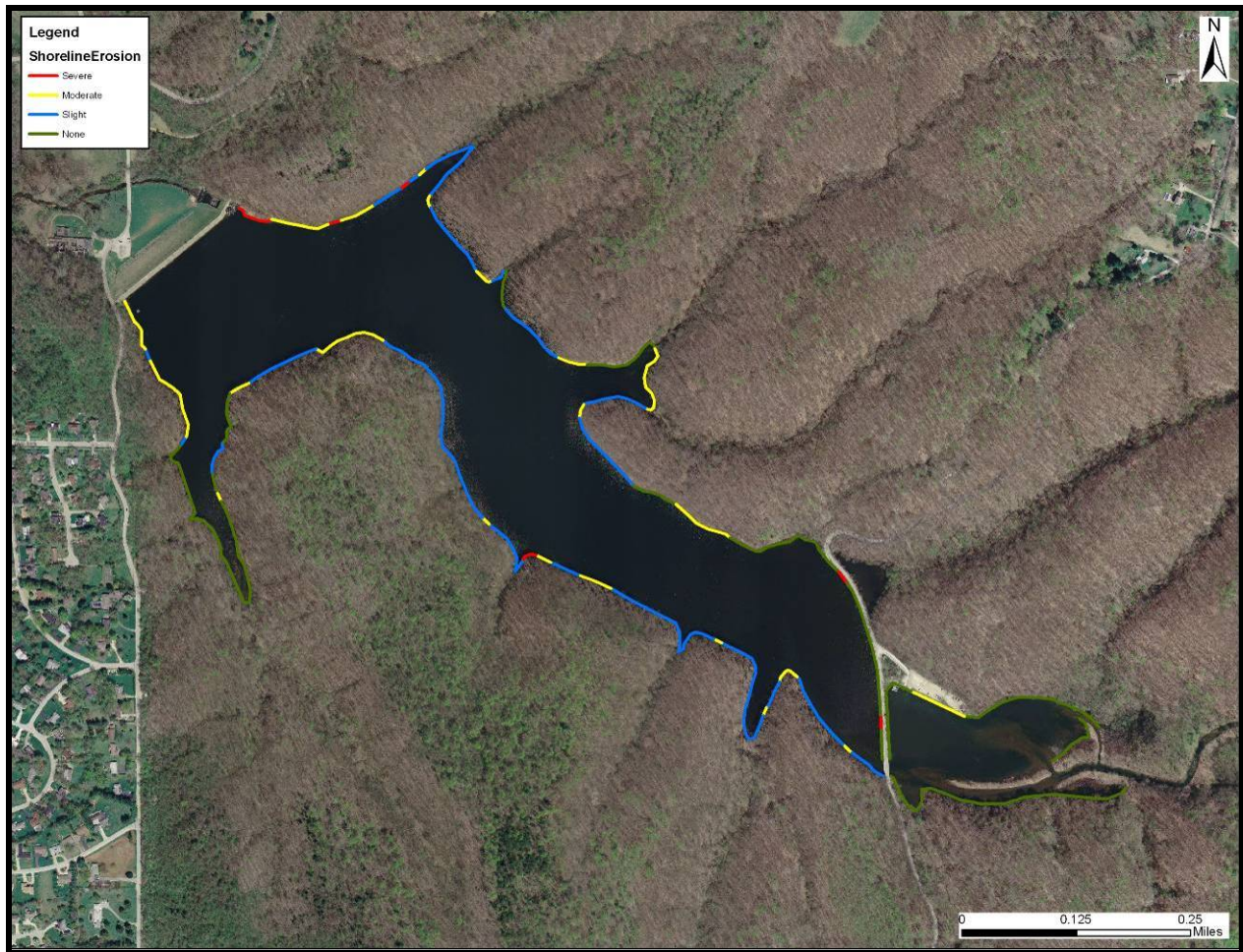


Figure 42. Shoreline erosion rating for the shoreline of Griffy Lake, October 2007.



Figures 43 and 44. Severely eroding shoreline documented along Griffy Lake's shoreline, October 2007.



Figures 45 and 46. Exposed roots and recently eroded soil within Griffy Lake along the shoreline adjacent to the dog exercise area.

Figures 47 through 48 detail moderately eroding shoreline along Griffy Lake. In most cases, moderately eroding shoreline could be stabilized using similar techniques to those detailed for the severely eroding shoreline. In most areas, a combination of rock toe, brush piles, breakwater shelves, and live staking of available woody materials will create a stable shoreline. However, in areas of high use such as those adjacent to the boat launch parking area (Figure 48) or in areas where lakeside fishing access is popular, board walks or fishing access points will need to be established.



Figures 47 and 48. Moderately eroding shoreline documented along Griffy Lake's shoreline, October 2007.

6.5.4 Miscellaneous Erosion

Several areas of minor erosion were identified throughout the property. Figure 37 documents locations of erosion identified throughout the Griffy Lake Nature Preserve. These erosion areas are typically associated with slumping of steeply sloped areas due to natural occurrence or due to erosion associated with anthropogenic impacts to steeply sloped areas. Figures 49 and 50 detail some of the naturally-occurring erosion within GLNP. In most cases, limiting access to these areas can help reduce further erosion. Additionally, seeding these areas with deep-rooted native species suited to steeply sloped areas and covering the newly seeded area with erosion control blanket can reduce erosion and increase the likelihood for seed germination. However, as some areas are located within densely wooded location, seed germination may occur at a

high rate. In these cases, identifying locations downhill of the erosion area as a soil accumulation area may be the best alternative. These areas should be located as far away from the lake as possible.



Figures 49 and 50. Sediment erosion areas identified within Griffy Lake Nature Preserve, May and September, 2007.

6.5.5 Recommendations

As previously detailed, recommendations for addressing property-wide and shoreline erosion at Griffy Lake Nature Preserve are dependent upon the location and erosion issues present at the specific site. General recommendations are detailed above to address streambed and bank erosion and shoreline erosion. However, without specific site information, including elevation and grading information, specific on-site recommendations cannot be generated. Therefore, it is recommended that the Bloomington Parks and Recreation Department use grant monies through the IDNR's Lake and River Enhancement (LARE) Program to complete a feasibility/design study to address both streambed and bank erosion within the streams draining to Griffy Lake and the shoreline erosion issues along Griffy Lake's shoreline.

7.0 GRIFFY LAKE INVENTORY

7.1 Mercury Assessment

In the 2007 Fish Consumption Advisory (FCA) for Indiana (ISDH et al. 2007), Griffy Lake largemouth bass greater than 11 inches in size are listed under Advisory Group 3 for mercury (Table 6). This means that adult males and females should eat no more than one meal of these fish per month. Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 should not eat any of these fish.